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A REVISION OF *PTEROSPERMUM* (MALVACEAE: DOMBEYOIDEAE) IN MALESIA

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The species of the tree genus *Pterospermum* Schreb. (Malvaceae: Dombeyoideae) in Malesia are revised. Twenty-six species of *Pterospermum* are recognised, six of which are new (*P. aureum* S.K.Ganesan, *P. borneense* S.K.Ganesan, *P. glabrum* S.K.Ganesan, *P. havilandii* S.K.Ganesan, *P. merrillianum* S.K.Ganesan and *P. zollingerianum* S.K.Ganesan) and one (*P. grewiifolium* Pierre) that is a new distributional record for Malesia. Identification keys are provided. All names are typified, and detailed descriptions of all species recognised are provided. Information on habitat, uses and conservation status is given for all species.

Keywords. Dombeyaceae, Dombeyoideae, Malesia, Malvaceae, *Pterospermum*.

Introduction

Pterospermum Schreb. is a genus of trees that is distributed in India, Sri Lanka, South China, through Southeast Asia to Maluku, and the Lesser Sunda Islands. It does not extend east of Maluku to the island of New Guinea, to the Pacific Islands to the south and east, or to Australia. There is no consensus with regards to the total number of species in the genus, with estimates ranging from 18 to 40 (Tang *et al*., 2007). This uncertainity is because a global monograph of *Pterospermum* has yet to be undertaken. Within Malesia, members of the genus are found in Brunei, Malaysia, Singapore, the Philippines, Timor-Leste and Indonesia (except the provinces of West Papua and Papua). The definition of Malesia here follows van Steenis (1950) and is shown in Fig. 1. There are 26 species of *Pterospermum* in Malesia. The centre of diversity is the Philippines, with 11 species.

Pterospermum species are used for timber (Kochummen, 1972; Cheek, 2007), as dyes (Burkill, 1966), and in traditional medicine (Burkill, 1966), with the flowers of at least one species having potential antidiabetic properties (Paramaguru *et al*., 2014). Some species from the Malay Peninsula are recorded as occurring on limestone (Turner, 1997 ['1995']), and it is possible that these species are drought adapted and, as such, could have wide use in urban forestry. Generally, *Pterospermum* species are able to regenerate well in disturbed forests, grow fast and produce wood of fair quality (Sosef *et al*., 1998). These attributes mean that *Pterospermum* has good potential for use in reforestation. Other species have ornamental potential (Corner, 1988) due to their large, showy, fragrant flowers and attractive leaves.

Linnaeus made reference to species that are now considered to be in the genus *Pterospermum* as early as 1753, in the first edition of *Species Plantarum*. However, he

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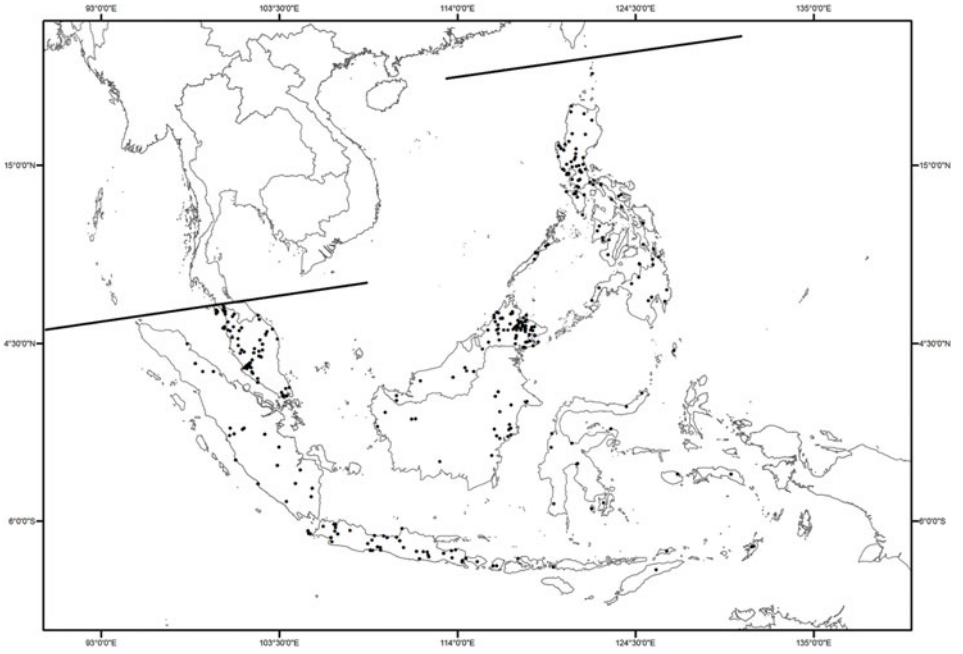

FIG. 1. Distribution of *Pterospermum* in Malesia. The lines show the approximate positions of the western and northern demarcation knots used by van Steenis (1950) to define Malesia.

described these species as belonging to the genus *Pentapetes* L. Schreber first described *Pterospermum* in 1791, in the eighth edition of *Genera Plantarum*. A key feature of Schreber's description that differentiates *Pterospermum* from *Pentapetes* is that the former is described as possessing "*semina alata*", or winged seeds, whereas the seeds of *Pentapetes* are wingless. Since then, there have been few doubts raised about the generic status of *Pterospermum*, although the assignment of *Pterospermum* to a family has changed through time.

Traditionally, *Pterospermum* was placed in Sterculiaceae Vent. (Endlicher, 1850; Bentham, 1862; Hutchinson, 1967; Takhtajan, 1997). However, recent phylogenetic analysis using both molecular and morphological data has led to the recognition of an expanded Malvaceae Juss., composed of the traditionally recognised families Bombacaceae, Malvaceae, Sterculiaceae and Tiliaceae, and for the Malvaceae *s.l.* to be divided into nine subfamilies (Alverson *et al.*, 1999; Bayer *et al.*, 1999; Stevens, 2001–; Bayer & Kubitzki, 2003). In this reorganisation, *Pterospermum* was placed in the Dombeyoideae Beilschm. An alternative classification was proposed by Cheek (2007), who recognised 10 families and placed *Pterospermum* in the Pentapetaceae Bercht. & J. Presl. Nomenclaturally, Pentapetaceae is now accepted as a synonym of Dombeyaceae Desf. (Turland *et al.*, 2018, Appendix IIB). Cheek's 2007 classification was not followed by APG III (Angiosperm Phylogeny Group, 2009). We consider that, because Dombeyoideae and Dombeyaceae do not differ in circumscription, it is a matter of opinion which rank to use. Here, we follow

Bayer *et al.* (1999), APG III (2009) and APG IV (Angiosperm Phylogeny Group, 2016) and consider *Pterospermum* in Malvaceae (Dombeyoideae).

The Dombeyoideae comprise 21 genera with about 381 species (Stevens, 2001–), distributed in the Paleotropics and Australia. Molecular studies utilising cpDNA data (Won, 2009) and nuclear data (Ganesan, 2016) have suggested a close relationship between *Pterospermum*, *Burretiodendron* Rehder, *Excentrodendron* H.T.Chang & R.H.Miao, *Nesogordonia* Baill. and *Schoutenia* Korth. Of these, only *Pterospermum* and *Nesogordonia p.p*. have winged seeds. However, in *Nesogordonia* the seeds are basally winged (Skema & Dorr, 2011), whereas in our study *Pterospermum* has been found to be apically winged.

Within Malesia, species of *Pterospermum* were first described by Blume from Java in 1825. Since then, there have been accounts or checklists of *Pterospermum* in individual islands or territories (e.g. Miquel, 1861; King & Gamble, 1891; Koorders & Valeton, 1895; Ridley, 1922; Merrill, 1923; Backer & Bakhuizen van den Brink, 1963; Kochummen, 1972; Wilkie & Berhaman, 2011; Ganesan, 2013) but no overall account for the Malesian region. Many species remain incompletely known, distributions within Malesia are unclear, and the circumscription of several species is in need of review. There are misapplied names, much nomenclatural confusion in the literature, and a lack of useful keys to the Malesian species. The taxonomic account presented here aims to address this and provide the taxonomic information needed for correct species identification, which is essential for the end user in fields such as molecular biology, ecology, forestry and arboriculture. The synonymies in this treatment reflect only those species described from Malesia. A limitation of this study is that the conservation assessments are based on old collections, because these are the only ones available.

Materials and Methods

Herbarium specimens from A, BO, CAL, E, FHO, K, KEP, L, NY, OXF, PNH, SAN, SAR, SING, UC and US were examined using standard herbarium methods. Measurements and colours are from dry herbarium material, unless otherwise stated. Character discussions and measurements cited in this paper are for specimens found in Malesia only and do not include species found outside the region, unless otherwise stated. The descriptive terminology, including definitions of colours, follows that of the *Kew Plant Glossary* (Beentje, 2012), unless otherwise stated. The Botanical Research and Herbarium Management System, BRAHMS (Filer, 2013), was used to database herbarium specimens.

The Characters

Habit

All species in Malesia are trees. Species that are relatively small are *Pterospermum jackianum* Wall. ex Mast. (up to 5 m tall and 5 cm in diameter at breast height, dbh) and *P. cumingii* Merr. & Rolfe (up to 6 m tall, dbh not recorded). Species that are relatively large are *Pterospermum elongatum* Korth. (up to 35 m tall and 50 cm dbh), *P. blumeanum*

Korth. (up to 35 m tall and 100 cm dbh) and *P. zollingerianum* S.K.Ganesan (up to 40 m tall and 45 cm dbh).

Buttresses

These have been recorded for all *Pterospermum* species in Malesia except for *P. cumingii*, *P. jackianum* and *P. pecteniforme* Kosterm.

Shoot orientation

Two types of shoot orientation are present: orthotropic (i.e. vertical) and plagiotropic (i.e. horizontal or at an angle to the vertical) (Fig. 2). Both shoot orientations can be found in all species. Orthotropic shoots are usually found in the sapling stage and from suckers at the base of trees. Plagiotropic shoots are usually found in mature trees.

The two shoot types differ in phyllotaxy, petiole length, leaf insertion and leaf shape (see Fig. 2). Orthotropic shoots have a spiral phyllotaxy, petioles that are more than twice as long as those in plagiotropic shoots, subpeltate to peltate petiole insertion, and in some species (e.g. *Pterospermum acerifolium* (L.) Willd., *P. diversifolium* Blume, *P. jackianum* and *P. pecteniforme*), leaves that are palmately lobed. Plagiotropic shoots have a distichous phyllotaxy, petioles that are less than half as long as those of orthotropic shoots, petiole insertion that is usually marginal, and leaves that are not lobed. For species delimitation and identification, it is important to compare like with like.

With their distichous phyllotaxy and relatively short petioles, most herbarium specimens seen in this study were of plagiotropic shoots. Therefore, the descriptions of leaf arrangement, petiole length, leaf insertion and leaf shape in this account are for plagiotropic shoots, unless otherwise stated. Owing to insufficient material, it is not possible to ascertain the usefulness of taxonomic characters in orthotropic shoots and leaves.

Bark

Bark texture ranges from smooth to scaly but never fissured. In colour it can be cinnamon, fawn, grey, grey-brown or light brown but never black. The inner bark colour is distinctively red with white streaks (Fig. 3), and the sapwood is white. The inner bark colour is useful in the field for identification of this genus.

Twigs

Twigs are glabrescent. The indumentum is composed of stellate hairs, except in *Pterospermum pecteniforme*, which has fimbrate scales.

Stipules

Stipules are mostly caducous, except in *Pterospermum acerifolium*, in which they are persistent. When they are caducous, stipules can still usually be observed at the tips of twigs

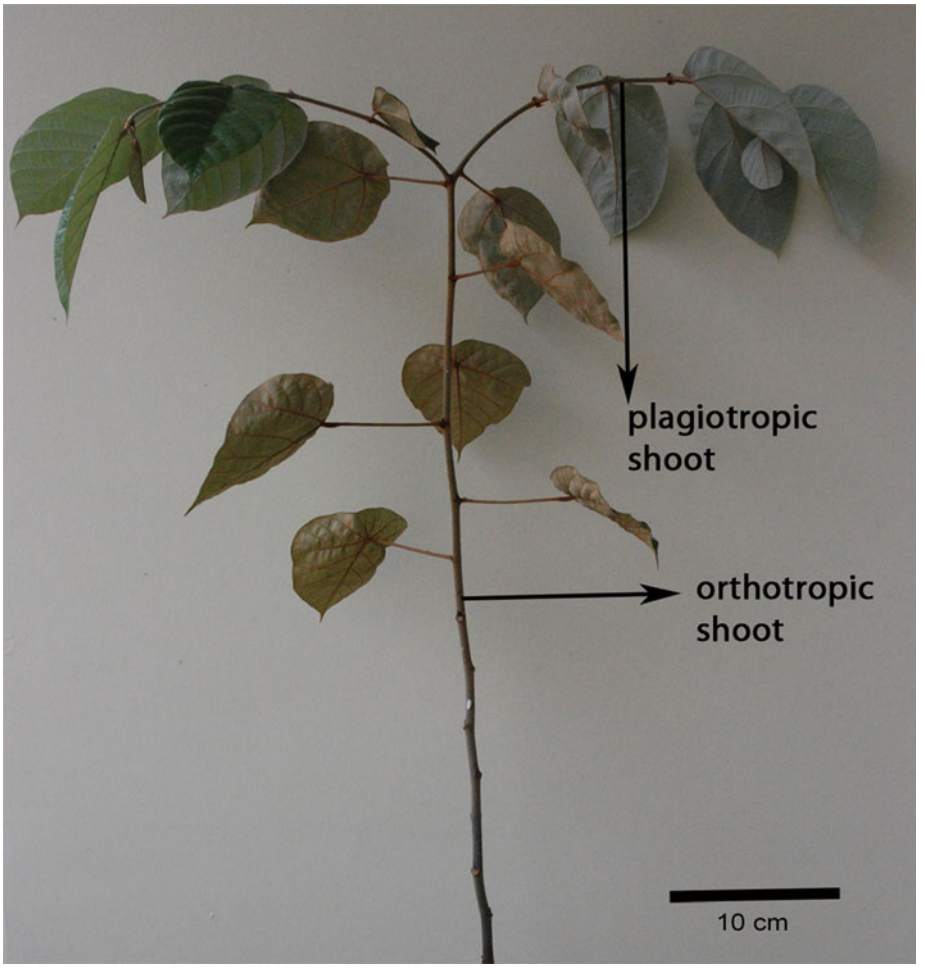

FIG. 2. Differences between orthotropic and plagiotropic shoots.

with newly opened leaves. There were no differences observed between the morphology of apical and axillary stipules. When present, stipule margins are entire, except for *Pterospermum acerifolium* and *P. grewiifolium* Pierre, in which they are divided.

Several species have stipular glands. These glands are white and found near the base of the stipules (Fig. 4). Ants have been observed visiting glands on living plants of *Pterospermum celebicum* Miq. in Kebun Raya Bogor, Indonesia, and *P. stapfianum* Ridl. in Singapore Botanic Gardens. This suggests that they are nectaries or Beltian body–type structures. Glands are most easily seen in living material and have been observed in *Pterospermum celebicum*, *P. elongatum* and *P. stapfianum*, and found to be absent from *P. acerifolium*, *P. diversifolium* and *P. jackianum*. The glands are not well preserved when dried and have been observed on herbarium specimens of only *P. celebicum* and *P. havilandii* S.K.Ganesan.

FIG. 3. Inner bark, *Pterospermum diversifolium*.

FIG. 4. Stipule with gland, *Pterospermum celebicum*.

Leaves

Leaf internode length ranges from relatively short, 0.5–2 cm long, in *Pterospermum cumingii*, to relatively long, 5.5–10 cm, in *P. acerifolium*.

The petiole insertion in *Pterospermum* species in Malesia is marginal in plagiotropic branches, except in *P. elmeri* Merr. and *P. stapfianum*, in which it is subpeltate. Marginal to subpeltate leaf bases are found in *Pterospermum celebicum* and *P. subpeltatum* Merr. ex C.B.Rob., and peltate leaf bases are common in *P. acerifolium*.

In most species, the leaf margin is repand (i.e. the margin is uneven or wavy). Exceptions are *Pterospermum diversifolium* and *P. grewiifolium*, which have leaf margins that are usually broadly toothed near the apex.

The leaves are usually subcoriaceous to coriaceous. However, in four species, *Pterospermum blumeanum*, *P. celebicum*, *P. elongatum* and *P. stapfianum*, they are chartaceous. When dry, chartaceous leaves have crinkly surfaces compared with the smooth surfaces of subcoriaceous leaves.

Leaf blade length ranges from the relatively short, 4–12.3 cm, of *Pterospermum cumingii*, to the relatively long, 18–30 cm, of *P. acerifolium*. *Pterospermum obliquum* Blanco is distinguished by its relatively narrow leaves, 1.7–4.1 cm, and *P. acerifolium* by its relatively wide leaves, 14–20 cm.

Leaf symmetry is determined by the relative widths of the two halves of the leaf at the middle point of the leaf blade length (Ellis *et al*., 2009). A summary of leaf symmetry in all Malesian species is given in the Table.

Lanceolate or falcate leaves are found in *Pterospermum borneense* S.K.Ganesan, *P. havilandii*, *P. merrillianum* S.K.Ganesan, *P. obliquum* and *P. subpeltatum*, and sometimes in *P. grewiifolium*, *P. niveum* S.Vidal, *P. parvifolium* Miq. and *P. sumatranum* Miq. The leaf shape in the other species is very variable.

The leaf bases of species are generally asymmetrical, as defined by Ellis *et al*. (2009). However, *Pterospermum acerifolium*, *P. diversifolium* and *P. pecteniforme* are symmetrical, and *P. elongatum*, *P. jackianum* and *P. stapfianum* are intermediate with symmetrical to slightly asymmetrical leaf bases.

Leaf base shape of *Pterospermum* species in Malesia ranges from obtuse, truncate, cordate, subcordate or oblique to round. Two groups of species can be distinguished using leaf base shape: those that usually have subcordate to cordate leaf bases (*Pterospermum diversifolium* and *P. elongatum*) and those that usually have oblique leaf bases (*P. blumeanum, P. borneense*, *P. celebicum*, *P. elmeri*, *P. javanicum* Jungh., *P. megalanthum* Merr., *P. merrillianum*, *P. subpeltatum* and *P. zollingerianum*). In *Pterospermum acerifolium*, when the petiole insertion is marginal, the leaf base is cordate, and when it is peltate, it is rounded. The leaf base shape in all other species varies widely.

In subcordate and cordate leaves, the depth of the basal lobes is measured from the point of insertion of the petiole to the plane of the lowest part of the lobe. This ranges from 0.1 to 5.5 cm long. Because there is much variation in this character within species, it is useful only in aiding the identification of *Pterospermum acerifolium*, which has the deepest lobes among the Malesian species (3–5.5 cm). In subpeltate or peltate leaves, the depth of the

TABLE. Summary of key characters of Malesian *Pterospermum*

Character	Species
Leaf symmetry	
Symmetrical	*P. acerifolium*, *P. cumingii*, *P. diversifolium*, *P. elongatum*, *P. glabrum*, *P. grewiifolium*, *P. jackianum*, *P. longipes*, *P. pecteniforme*, *P. stapfianum*, *P. zollingerianum*
Asymmetrical	*P. aureum*, *P. blumeanum*, *P. borneense*, *P. fuscum*, *P. havilandii*, *P. megalanthum*, *P. obliquum*, *P. subpeltatum*, *P. sumatranum*
Variable	*P. celebicum*, *P. havilandii*, *P. javanicum*, *P. merrillianum*, *P. niveum*, *P. parvifolium*
Pedicel length	
≤ 20 mm	*P. acerifolium*, *P. blumeanum*, *P. borneense*, *P. celebicum*, *P. cumingii*, *P. diversifolium*, *P. glabrum*, *P. jackianum*, *P. obliquum*, *P. parvifolium*, *P. pecteniforme*, *P. subpeltatum*
> 20 mm	*P. borneense*, *P. elmeri*, *P. elongatum*, *P. grewiifolium*, *P. longipes*, *P. megalanthum*, *P. merrillianum*, *P. niveum*, *P. stapfianum*
Width of sepals	
≤ 4 mm	*P. blumeanum*, *P. borneense*, *P. celebicum*, *P. cumingii*, *P. elmeri*, *P. elongatum*, *P. glabrum*, *P. grewiifolium*, *P. havilandii*, *P. jackianum*, *P. longipes*, *P. merrillianum*, *P. obliquum*, *P. pecteniforme*, *P. stapfianum*, *P. subpeltatum*
> 4 mm	*P. acerifolium*, *P. javanicum*, *P. megalanthum*, *P. niveum*
Indumentum on outer surface of sepal	
Stellate	*P. borneense*, *P. cumingii*, *P. diversifolium*, *P. elmeri*, *P. elongatum*, *P. glabrum*, *P. grewiifolium*, *P. havilandii*, *P. jackianum*, *P. megalanthum*, *P. merrillianum*, *P. obliquum*, *P. parvifolium*, *P. pecteniforme*, *P. stapfianum*, *P. subpeltatum*
Tomentose	*P. acerifolium*, *P. blumeanum*, *P. fuscum*, *P. javanicum*, *P. sumatranum*
Woolly	*P. celebicum*, *P. niveum*
Length of androgynophore	
< 10 mm	*P. blumeanum*, *P. celebicum*, *P. cumingii*, *P. elmeri*, *P. fuscum*, *P. glabrum*, *P. grewiifolium*, *P. havilandii*, *P. jackianum*, *P. javanicum*, *P. merrillianum*, *P. obliquum*, *P. parvifolium*, *P. subpeltatum*, *P. sumatranum*
≥ 10 mm	*P. acerifolium*, *P. borneense*, *P. diversifolium*, *P. longipes*, *P. pecteniforme*, *P. stapfianum*
Style indumentum	
Glabrous	*P. acerifolium*, *P. elongatum*, *P. fuscum*, *P. megalanthum*, *P. merrillianum*, *P. parvifolium*
Hairy at base	*P. borneense*, *P. celebicum*, *P. elmeri*, *P. glabrum*, *P. grewiifolium*, *P. havilandii*, *P. javanicum*, *P. longipes*, *P. niveum*, *P. obliquum*, *P. pecteniforme*, *P. stapfianum*, *P. subpeltatum*

TABLE. *(Continued)*

Character	Species
Hairy in lower half	*P. blumeanum*, *P. cumingii*, *P. diversifolium*
Hairy throughout	*P. jackianum*
Stipe	
Present	*P. acerifolium*, *P. cumingii*, *P. diversifolium*, *P. pecteniforme*
Absent	*P. aureum*, *P. blumeanum*, *P. borneense*, *P. celebicum*, *P. elongatum*, *P. glabrum*, *P. grewiifolium*, *P. javanicum*, *P. longipes*, *P. merrillianum*, *P. niveum*, *P. obliquum*, *P. stapfianum*, *P. subpeltatum*, *P. sumatranum*, *P. zollingerianum*
Valve margin	
Raised	*P. acerifolium*, *P. blumeanum*, *P. diversifolium*, *P. pecteniforme*, *P. zollingerianum*
Plane	*P. celebicum*, *P. cumingii*, *P. elongatum*, *P. grewiifolium*, *P. jackianum*, *P. niveum*, *P. obliquum*, *P. stapfianum*

basal lobe is measured from the point of insertion of the petiole to the base of the leaf. This is useful in distinguishing among *Pterospermum acerifolium*, *P. celebicum*, *P. elmeri*, *P. stapfianum* and *P. subpeltatum*.

In this account, the term *cuspidate* refers to a leaf apex that is abruptly shortly acuminate, following the terminology of Ricketts (1956), and is found in *Pterospermum diversifolium*, *P. glabrum* S.K.Ganesan and *P. megalanthum*. In *Pterospermum aureum* S.K.Ganesan, the leaf apex ranges from cuspidate to caudate, in *P. javanicum* from acuminate to occasionally cuspidate, and in *P. stapfianum* from cuspidate to acuminate. All other species of *Pterospermum* have a wide range of leaf apex shapes.

Pterospermum aureum is unique in that its leaf upper surface dries lighter in colour than the leaf lower surface. In all other species, the upper surface dries darker than the lower surface or is concolorous.

The leaf lower surface is usually densely covered (i.e. hairs touching each other) with an indumentum of simple and/or stellate hairs, with the simple hairs forming a woolly indumentum that is white to tawny coloured (e.g. Fig. 5A). However, some species have fawn to chestnut-coloured stellate hairs interspersed over a layer of simple woolly hairs (Fig. 5C), and others have an indumentum of only dense stellate hairs (Fig. 5B). In *Pterospermum pecteniforme* the stellate hairs are compressed dorsoventrally and appear as silvery fimbriate scales (Fig. 5D). The type and colour of hairs, but not hair architecture or length, are useful in distinguishing species.

In all species, the midrib is sunken on the leaf upper surface and prominent on the leaf lower surface. The number of basal veins, in conjunction with other characters, can be useful in species identification, with *Pterospermum jackianum* having 2(–4) basal veins and *P. acerifolium* 8(–10).

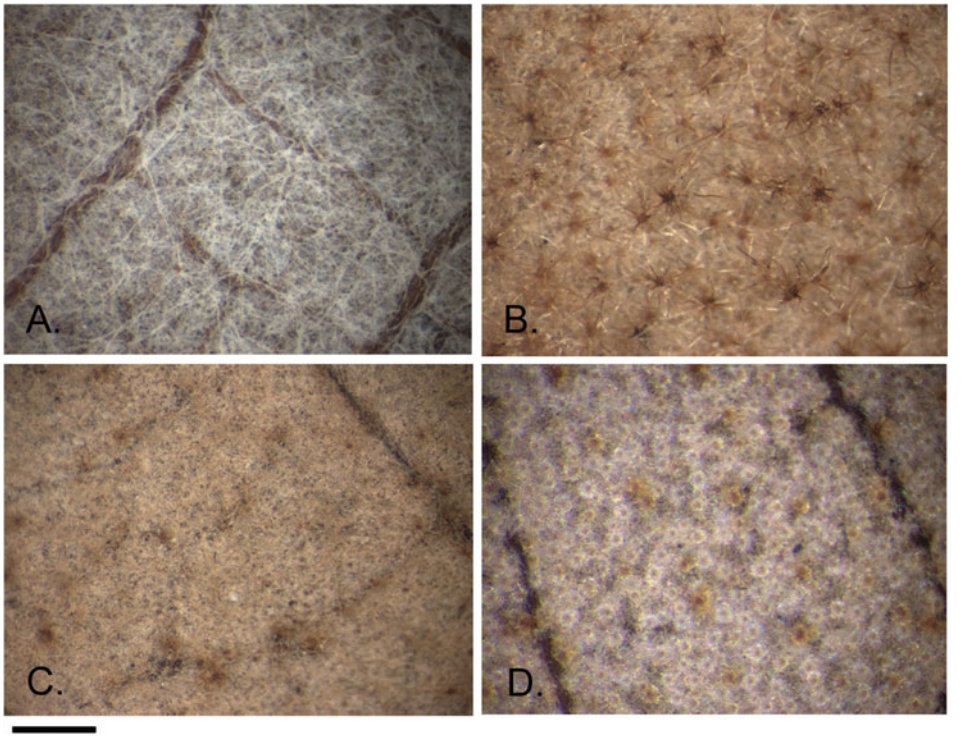

FIG. 5. Indumentum types in *Pterospermum*: A, white long woolly hairs, *P. niveum*; B, stellate hairs, *P. sumatranum*; C, short woolly hairs with interspersed stellate hairs, *P. celebicum*; D, silvery fimbriate scales, *P. pecteniforme*. Scale: 500 μM.

In the taxonomic account, the number of secondary veins does not include the basal veins. The secondary veins are always pinnately arranged and are sunken on the leaf upper surface and prominent on the leaf lower surface. The number of pairs of secondary veins is taxonomically useful in distinguishing some species, when used in conjunction with other characters. *Pterospermum aureum* and *P. borneense* have the lowest number of secondary veins, with 3 or 4, whereas *P. jackianum* has the highest, with 9–11 pairs.

Tertiary veins are scalariform and widely spaced. They are not visible on the leaf upper surface but are visible on the lower surface in all species except *Pterospermum aureum*, *P. havilandii* and *P. zollingerianum*. Quaternary veins are prominent in *Pterospermum acerifolium* but indistinct in all other species.

Petioles

Petiole length, when used in conjunction with other characters, can distinguish some *Pterospermum* species. Petiole length is shortest in *Pterospermum parvifolium* (2–4 mm) and *P. elmeri* (3–4 mm), and longest in *P. acerifolium* (20–50 mm).

The petiole surface in all species is densely covered by an indumentum of stellate hairs, except in *Pterospermum pecteniforme*, which has fimbriate scales.

Inflorescence

Most species in Malesia have one to three flowers in a cyme, but in *Pterospermum grewiifolium*, *P. jackianum*, *P. megalanthum*, *P. merrillianum* and *P. pecteniforme* only solitary flowers are found. All species in Malesia have axillary flowers except *Pterospermum longipes* Merr., which can have axillary or pseudoterminal flowers.

Peduncular bracts are caducous in all species except *Pterospermum acerifolium*, in which they are persistent.

Epicalyx and bracts

In this account, the bracts that are found on the pedicel are collectively termed the *epicalyx*. All *Pterospermum* species in Malesia have free bracts, and most species have three, except *P. elmeri*, which has five, and *P. obliquum*, which has seven. The bracts are caducous in most species but persist until anthesis in *Pterospermum cumingii*, *P. elmeri* and *P. obliquum*. The bracts of *Pterospermum elmeri* and *P. obliquum* are often in conspicuous clusters in herbarium specimens, unlike other species in the genus. The bract margins are entire in all species except *Pterospermum acerifolium*, *P. elmeri*, *P. grewiifolium* and *P. subpeltatum*, in which they are divided.

Flowers

Species can be grouped into those that have relatively long pedicels (greater than 20 mm long) and those that have relatively short pedicels (equal to or less than 20 mm long) (see Table). For solitary flowers, the pedicel is measured from the base of the calyx to the point of insertion in the twig. For those in a cyme, it is measured from the base of the calyx to the point of insertion on the inflorescence stalk. The pedicel length of *Pterospermum sumatranum* (17–26 mm) is intermediate between the two groups.

Sepals

Sepal length is measured from the point at which the pedicel meets the base of the sepal to the apex of the sepal. The sepals of all *Pterospermum* species are longer than the petals. Most species have sepals that are less than or equal to 90 mm long, but both *Pterospermum acerifolium* and *P. diversifolium* have sepals ranging from 100 to 150 mm long. Several species can be grouped into those that usually have sepals narrower or equal to 4 mm wide and those that are wider than 4 mm (see Table).

The outer surface of the sepal is covered with a dense indumentum of hairs. Three types of covering can be distinguished: those that are clearly stellate, those that are tomentose, and those that are woolly (see Table). The surface of *Pterospermum longipes* varies from

woolly to tomentose. The inner surfaces of sepals are hairy in all species except *Pterospermum havilandii*, in which they are glabrous.

Petals

The outer and inner surfaces of the petals are sometimes sparsely covered in stellate hairs. However, because most petals on herbarium specimens are poorly preserved, it is not possible to ascertain their usefulness in species identification. The petals of *Pterospermum* are brittle and delicate, and usually dry twisted. This makes it difficult to measure their length, width and shape. However, they are generally less than or equal to 50 mm long, apart from *Pterospermum acerifolium* and *P. diversifolium*, in which they range from 80 to 140 mm long.

Androgynophore

The androgynophore is a stalk (expansion of the receptacle) that holds both stamens and ovary above the insertion of the petals and is found in all *Pterospermum* species. Many Malesian species can be categorised into those with androgynophores less than 10 mm in length and those with androgynophores that are 10 mm or more in length (see Table).

Style

The indumentum of the style in Malesian species can be grouped into four types (see Table). The styles of *Pterospermum aureum* and *P. zollingerianum* are unknown.

Fruit

The fruit is a capsule that is dehiscent along the margins of five valves, with each valve containing many seeds. The fruits are usually fusiform (i.e. spindle-shaped) to cylindrical, but *Pterospermum grewiifolium* has an ovoid to cylindrical fruit and that of *P. diversifolium* is frequently falcate. Most species have fruits that are chestnut to black in colour, except *Pterospermum grewiifolium*, *P. obliquum* and occasionally *P. pecteniforme*, in which the fruit are tawny in colour. Most species in Malesia are tomentose glabrescent. However, *Pterospermum longipes* is glabrous; *P. cumingii*, *P. javanicum* and *P. zollingerianum* are persistently tomentose; and *P. pecteniforme* is persistently scaly. The pedicels of most species are greater than 2 cm long, but in *Pterospermum cumingii* and *P. havilandii* they are 1–1.3 cm long and in *P. pecteniforme* they are 1.4–1.5 cm long.

In this account the stipe, the basal part of the fruit that is adnate to the fruit pedicel, is considered to be distinct and conspicuous when there is an abrupt change in fruit diameter, and it is considered to be absent when the change in fruit diameter is gradual. This character is consistent within species and varies between species, allowing most species in Malesia to

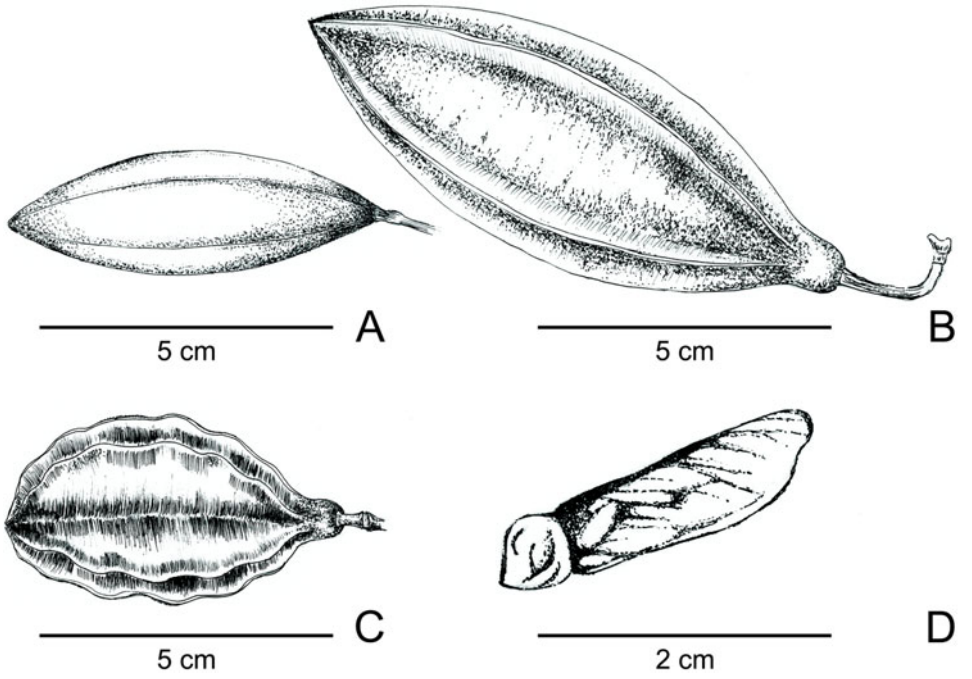

FIG. 6. Fruit valve margin types in *Pterospermum*. A, Fruit valve with plane margin, *Pterospermum elongatum*; B, fruit valve with raised margin, *P. diversifolium*; C, fruit valve with wavy margin, *P. pecteniforme*; D, seed, *P. elongatum*. Drawing by Violette Chye Lay Choon.

be divided into two groups (see Table). The fruits of *Pterospermum elmeri*, *P. fuscum* Korth., *P. havilandii*, *P. jackianum* and *P. parvifolium* are unknown.

The fruit valve, the area between each dehisced segment of fruit, provides useful taxonomic characters. Whether the valve margin is plane or raised (Fig. 6A,B) can divide species into two groups (see Table). In the group that has raised valve margins, all species form flanges (projecting flat rims more than 1 cm in height) except for *Pterospermum blumeanum*, which has a ribbed surface (i.e. less than 5 mm in height). Valve margin shape is entire for all species except *Pterospermum pecteniforme*, in which it is wavy and diagnostic of that species (Fig. 6C).

Seeds

The apically winged seeds are arranged in overlapping rows in the longitudinal axis of each fruit valve. Seed placentation is axile. All species have glabrous, membraneous and translucent winged seeds (Fig. 6D). This structure slows the speed of the fall of the seed by using a 'helicopter' propelling effect and aids dispersal by wind (Van der Pijl, 1982). Seed length ranges from 20 to 60 mm and width from 5 to 17 mm. Seed characters have not been found to be taxonomically useful.

Pollination

The flowers of *Pterospermum* conform to the syndrome of phalaenophily (moth pollination) (Faegri & Van Der Pijl, 1971) in having fragrant white flowers that open mainly at night. The flowers also have free petals, almost free calyx lobes and nectar deeply hidden at the base of the calyx.

In the literature, only two references to pollinators of *Pterospermum* species are found. Kato *et al.* (2008) reported visitations by butterflies to *Pterospermum cinnamomeum* Kurz (a species that occurs in Laos, outside Malesia), and Sakai *et al.* (1999) suggested bat pollination from the flower morphology of *P. fuscum* (a species found in Sarawak). However, this is questionable, given that bat pollination requires robust flowers for bats to cling on to (Faegri & Van der Pijl, 1971) and the flowers of many *Pterospermum* species are delicate.

Taxonomic Treatment

Pterospermum Schreber, Gen. Pl., ed. 8[a], 2: 461 (1791) *nom. cons.*; Willdenow, Sp. Pl., ed. 4, 3(1): 728 (1800); de Candolle, Prodr. 1: 500 (1824); Blume, Bijdr. Fl. Ned. Ind. 87 (1825); Blanco, Fl. Filip. 528 (1837); Miquel, Fl. Ned. Ind. 1, 2: 191 (1859); Bentham in Bentham & Hooker *f.*, Gen. Pl. 1: 220 (1862); Masters in Hooker *f.*, Fl. Brit. India 1: 366 (1874); King & Gamble, J. Asiat. Soc. Bengal, Pt 2, Nat. Hist. 60(3): 83 (1891); Schumann in Engler & Prantl, Nat. Pflanzenfam. 3: 93 (1895); Koorders & Valeton, Bijdr. Boomsoort. Java 2: 181 (1895); Gagnepain in Lecomte, Fl. Indo-Chine 1: 497 (1910); Merrill, Sp. Blancoan. 260 (1918); Merrill, Enum. Philipp. Fl. Pl. 3: 49 (1923); Ridley, Fl. Malay Penins. 1: 282 (1922); Backer & Bakhuizen *f.*, Fl. Java 1: 409 (1964); Kochummen in Whitmore, Tree Fl. Malaya 2: 367 (1973); Shea in Cockburn, Trees of Sabah 1: 237 (1976); Ashton, Man. Non-Dipterocarp. Trees Sarawak 400 (1988); Corner, Wayside trees Mal. Ed. [3]: 709 (1988); Chandra in Sharma & Sanjappa, Fl. India 3: 447 (1993); Turner, Gard. Bull. Singapore 47(2): 476 (1997 [‘1995’]); Verdcourt in Dassanayake *et al.*, Revis. Handb. Fl. Ceylon 9: 422 (1995); Wilkie in Argent *et al.*, Man. Non-Dipterocarp. Trees Central Kalimantan 2: 609 (1997); Phengklai in Santisuk & Larsen, Fl. Thailand 7: 599 (2001); Bayer & Kubitzki in Kubitzki & Bayer, Fam. Gen. Vasc. Pl. 5: 267 (2003); Cheek in Heywood *et al.*, Fl. Pl. Fam. World 248 (2007); Tang *et al.* in Wu *et al.*, Fl. China 12: 327 (2007); LaFrankie, Trees Trop. Asia 479 (2010); Wilkie & Berhaman in Soepadmo *et al.*, Tree Fl. Sabah Sarawak 7: 368 (2011); Ganesan, Nature in Singapore 6: 149 (2013). – Type species: *Pterospermum suberifolium* (L.) Willd (designated by Green, Prop. Brit. Bot. 105 [1929]). Type: Sri Lanka, c.1672–1677, *P. Hermann s.n.* (first-step lecto BM, Herb. Hermann 1: 10 FZ 250 [BM000621262, BM000621263], selected by Verdcourt in Dassanayake *et al.*, Revis. Handb. Fl. Ceylon 9: 423 (1995); second-step lecto BM, Herb. Hermann [BM000621262], designated here; isolecto BM, Herb. Hermann [BM000621263]).

Sczegleewia Turcz., Bull. Soc. Nat. Moscou 31, 1: 233 (1858). – Type species: *Sczegleewia involucrata* Turcz. (= *Pterospermum obliquum* Blanco).

Pterospermadendron Kuntze, Rev. Gen. 1: 80 (1891) nom. illeg. superfl. – Type species: *Pterospermadendron acerifolium* (L.) Kuntze (= *Pterospermum acerifolium* (L.) Willd.).

Velaga Adan. ex Gaertn., Fruc. Sem. Pl. 2: 245 (1791). – Type species: *Velaga xylocarpa* Gaertn. (= *Pterospermum xylocarpum* (Gaertn.) Oken).

Small to large trees, to 45 m tall, dbh to 100 cm, usually with short buttresses, sometimes with multiple stems arising from tree base; crown somewhat flattened, coppery or silvery. *Bark* cinnamon, fawn, grey, grey-brown, light brown, smooth or scaly, sometimes lenticellate; inner bark red with white streaks; sapwood white. *Twigs* sometimes phyllomorphic, plagiotropic shoots with distichous phyllotaxy, new twigs covered in cinereous, stramineous, fawn, tawny, chestnut-coloured to fuscous hairs becoming glabrous, rarely with silvery scales, mature twigs glabrous and sepia to black. *Stipules* caducous to persistent, sometimes with glands, stipules entire or dissected, triangular to subulate to filiform, 0.8–20 mm long. *Leaves* alternate or spiral, internodes 0.5–11 cm long; buds small and covered with chestnut-coloured hairs; leaf simple, sometimes heterophyllous (i.e. unlobed or lobed), margin entire, repand to rarely toothed near apex; lamina 4–30 cm long, 1.7–20 cm wide, symmetrical to occasionally asymmetrical, ovate, obovate, elliptic, orbicular, lanceolate, falcate to oblong, base often asymmetrical, sometimes symmetrical, rarely peltate, cuneate to cordate, apex obtuse, acute, acuminate, rounded cuspidate to caudate; blade chartaceous to subcoriaceous, discolorous, upper surface usually glabrescent, lower surface persistently densely hairy, rarely silvery scaly; midrib sunken above, prominent below, secondary veins pinnatifid, 3–11 pairs, tertiary veins scalariform and widely spaced. *Petioles* usually short, with white to chestnut-coloured hairs. *Pedicels* usually short. *Epicalyx bracts* usually 3, occasionally up to 7, usually caducous, rarely persistent, entire or divided. *Flowers* in bud ovoid to cylindrical, covered in tawny to chestnut-coloured hairs, open flowers actinomorphic, perfect, fragrant, solitary or in 2- or 3-flowered cymes, axillary; sepals 5, free, or slightly connate at base, yellow to green, drying cinnamon in colour, symmetrical, ensiform, subcoriaceous, hairy, narrower and longer than petals, nectaries at base of sepals on inner surface. *Petals* 5, free, white when fresh, clawed at base, usually asymmetrical, spathulate, membraneous to slightly fleshy, usually glabrous, dehydrating rapidly to a chestnut colour; androecium and gynoecium borne on a stalk (androgynophore); stamens 15, in 5 bundles of 3 each alternating with 1 staminode; staminodes longer than stamens, pustullate, anthers with an appendage at tip of connective; ovary ellipsoid, ovoid or globose, hairy, 5-locular, ovules numerous; style hairy or glabrous, clavate, slightly longer than staminodes; stigma 5, grooved, twisted. *Fruit* usually chestnut-coloured to black, occasionally tawny, obovoid, ovoid, fusiform, cylindrical, oblong to falcate, dry leathery to woody capsule when mature, 5-locular, dehiscent along locules, with or without prominent stipe, smooth or angular, with or without flanges, glabrescent or hairy. *Seeds* arranged in overlapping rows on longitudinal axis of fruit valves, dry when mature, glabrous, with apical membraneous wings, cotyledons simple.

Distribution. India, Bangladesh, Sri Lanka, Nepal, Bhutan, Myanmar, China, Vietnam, Laos, Cambodia and Thailand. In Malesia: Malaysia, Singapore, Brunei, the Philippines, Timor-Leste and Indonesia (except the provinces of West Papua and Papua). See Fig. 1.

Habitat. Tree of alluvial, limestone, mixed dipterocarp, riparian, secondary and ultramafic forests.

Etymology. The name *Pterospermum* comes from the Greek *ptero*, meaning 'wing', and *spermum*, meaning 'seed', and refers to the winged seed.

The name *Pterospermum* is listed in Appendix III of the *International Code of Nomenclature for Algae, Fungi and Plants* (*ICN*) as a conserved name (*nomen conservandum*), with the type *P. suberifolium* (L.) Willd. (Turland *et al*., 2018).

Green (1929) gave the type species of *Pterospermum* as *Pterospermum suberifolium*, the basionym of which is *Pentapetes suberifolia* L. Verdcourt (1995) designated as lectotype Hermann, volume 1, page 10 (BM-Hermann Herbarium). There are annotations on this material that match Linnaeus's handwriting. The material that Verdcourt designated as the lectotype was later given two barcodes, BM000621262 and BM000621263. Both these are of the same species, bear the same annotation ('250'), are sterile, and are of similar quality. We have selected BM000621262 for a second-step lectotypification, because it is the one physically nearest the annotations made by Linnaeus.

The seventeenth-century material of the type of *Pterospemum suberifolium* does not indicate a type locality. According to the protologue, the distribution of this species is India. Verdcourt (1995), who carried out the lectotypification, gave the type location as India. However, the material has an annotation in Sinhala, a script from Sri Lanka, which when transliterated reads 'Valangu' (Subhani Ranasinghe, Peradeniya Botanic Gardens, Sri Lanka, personal commuication). There are no annotations in the scripts of any Indian languages. Valangu is a vernacular name of *Pterospermum suberifolium* in Sri Lanka (Verdcourt, 1995). There is also an annotation in Latin script on the type that reads 'Welagha'. Based on the language of the annotations, the type locality is probably Sri Lanka, not India.

The generic synonyms of *Pterospermum* are the following.

- *Pterospermadendron* Kuntze. Kuntze (1891) did not provide a description of *Pterospermadendron* but did refer to Amman (1736), who coined the name and gave a description. Under Article 38.1 of the *ICN* (Turland *et al*., 2018), this makes the name valid. However, because 1753 is the starting point for plant nomenclature, *Pterospermadendron* is only considered to be published by Kuntze in 1891 and therefore does not have priority over *Pterospermum* from 1791. In addition, Kuntze (1891) gave *Pterospermum* Schreb. in synonymy, which under Article 52.1 of the *ICN* (Turland *et al*., 2018) means that *Pterospermadendron* is illegitimate because it is a superfluous name for *Pterospermum*. The type species of *Pterospermadendron* Kuntze is *Pterospermadendron acerifolium* (L.) Kuntze, which is a superfluous name based on *Pterospermum acerifolium* (L.) Willd.

- *Sczegleewia* Turzc. The name *Sczegleewia* Turcz. was validly published in 1858 by Turczaninow, together with its only species, *Sczegleewia involucrata* Turcz. Merrill (1923) considered this species to be a synonym of *Pterospermum obliquum* Blanco. It is widely accepted that Blanco did not preserve his specimens (Merrill, 1918), and we have not found any *Pterospermum* specimens collected by Blanco. However, the protologue and type of *Sczegleewia involucrata* is a perfect match to the protologue and neotype of *Pterospermum obliquum* as currently delimited and is undoubtedly the same taxon. It follows, therefore, that *Sczegleewia* is a later synonym of *Pterospermum*.
- *Velaga* Adan. ex Gaertn. The name *Velaga* Adans. was published in 1763 (Adanson, 1763) but is illegitimate because it is a superfluous name for *Pentapetes* (Linnaeus, 1753), which Adanson cited as a synonym. Gaertner in 1791 published *Velaga* validly and attributed the authorship to Adanson. He did not indicate original material, but two species are mentioned in the protologue, *Velaga xylocarpa* Gaertn. and *V. globosa* Gaertn. The former has been recombined to *Pterospermum xylocarpum* (Gaertn.) Oken, and the latter was found by de Wilde & Duyfjes (2016) to be a heterotypic synonym of *Lagerstoemia indica* L. (Lythraceae). We agree with these findings and select *Velaga xylocarpa* Gaertn. as the type species of *Velaga* Adan. ex. Gaertn. The protologue of *Velaga xylocarpa* contains an illustration and states that the specimen examined was from the Leiden herbarium (L). Checks were made with L, where Gaertner consulted the van Royen collection, and TUB, where Gaertner's herbarium is deposited but no specimens of the original material could be located. Therefore, the illustration t. 133, in Gaert. 1791. Fruct. Sem. Pl. 2, is here designated the lectotype of *Velaga xylocarpa* Gaertn.

Key to species of Pterospermum *in Malesia*

1a. Leaf lower surface covered with silvery fimbriate scales _____ **22. P. pecteniforme**
1b. Leaf lower surface covered with stellate or simple straight hairs _____ 2

2a. Leaf lower surface covered with white to cream woolly hairs _____ 3
2b. Leaf lower surface covered with fawn, tawny, golden or chestnut-coloured woolly hairs, stellate hairs, or a combination of both _____ 4

3a. Flower pedicel less than 30 mm long _____ **19. P. niveum**
3b. Flower pedicel more than or equal to 40 mm long _____ **16. P. longipes**

4a. Leaf upper surface pubescent _____ 5
4b. Leaf upper surface glabrous or glabrescent _____ 6

5a. Leaf upper surface drying darker in colour than the lower surface; leaf lower surface tawny in colour _____ **10. P. fuscum**
5b. Leaf upper surface drying lighter in colour than the lower surface; leaf lower surface golden in colour _____ **2. P. aureum**

6a. Leaf margin broadly toothed or broadly toothed towards apex _____ 7
6b. Leaf margin entire to repand or sinuate _____ 9

7a. Leaf base asymmetrical; flower pedicel more than or equal to 30 mm long **12. P. grewiifolium**
7b. Leaf base symmetrical; flower pedicel less than 20 mm long _____ 8

8a. Quaternary veins very visible on leaf lower surface (with the naked eye); stipules persistent _____ **1. P. acerifolium p.p**.
8b. Quaternary veins faintly visible to not visible on leaf lower surface (with the naked eye); stipules caducous _____ **7. P. diversifolium p.p**.

9a. Leaf chartaceous _____ 10
9b. Leaf coriaceous _____ 17

10a. Fruit valve margin raised _____ 11
10b. Fruit valve margin plane _____ 12

11a. Fruit valve margin forming a flange _____ **26. P. zollingerianum**
11b. Fruit valve margin forming a rib _____ **3. P. blumeanum**

12a. Fruit persistently tomentose _____ 13
12b. Fruit glabrous or glabrescent _____ 14

13a. Petiole more than or equal to 15 mm long; fruit less than 5 cm long **6. P. cumingii**
13b. Petiole less than 15 mm long; fruit more than 5 cm long _____ **15. P. javanicum**

14a. Petiole insertion in mature leaf subpeltate to peltate _____ 15
14b. Petiole insertion in mature leaf marginal _____ 16

15a. Leaf base rounded to occasionally truncate; pedicel length greater than or equal to 20 mm _____ **23. P. stapfianum**
15b. Leaf base oblique to subcordate; pedicel length less than 20 mm **5. P. celebicum p.p**.

16a. Quaternary veins not visible (using hand lens) on leaf lower surface; pedicel more than or equal to 30 mm long _____ **9. P. elongatum**
16b. Quaternary veins visible (using hand lens) on leaf lower surface; pedicel less than or equal to 20 mm long _____ **5. P. celebicum p.p**.

17a. Leaf base symmetrical _____ 18
17b. Leaf base asymmetrical _____ 20

18a. Leaf base obtuse to truncate _____ **14. P. jackianum p.p**.
18b. Leaf base rounded to cordate _____ 19

19a. Quaternary veins very visible (using hand lens) on leaf lower surface; stipules persistent _____ **1. P. acerifolium p.p**.
19b. Quartenary veins faintly visible to not visible (using hand lens) on leaf lower surface, stipules caducous _____ **7. P. diversifolium p.p**.

20a. Secondary veins (excluding basal veins) 9 or more pairs _____**14. P. jackianum p.p**.
20b. Secondary veins (excluding basal veins) 8 or fewer pairs _____ 21

21a. Basal veins (excluding midrib) 3 or fewer _____ 22
21b. Basal veins (excluding midrib) 4 or more _____ 30

22a. Flower pedicel more than 30 mm long _____ 23
22b. Flower pedicel less than or equal to 25 mm long _____ 24

23a. Leaf less than or equal to 3 cm wide; sepal less than or equal to 1.9 mm wide **4. P. borneense p.p**.
23b. Leaf more than or equal to 3.8 cm wide; sepal more than or equal to 2.8 mm wide **18. P. merrillianum**

24a. Sepal inner surface glabrous _____ **13. P. havilandii**
24b. Sepal inner surface pubescent _____ 25

25a. Leaf base obtuse to truncate _____ **11. P. glabrum p.p**.
25b. Leaf base oblique _____ 26

26a. Epicalyx bracts persistent and in conspicuous clusters _____ 27
26b. Epicalyx bracts caducous _____ 28

27a. Petiole insertion in leaf on mature twig subpeltate _____ **8. P. elmeri p.p**.
27b. Petiole insertion in leaf on mature twig marginal _____ **20. P. obliquum p.p**.

28a. Petiole insertion in leaf on mature twig both marginal and subpeltate **24. P. subpeltatum**
28b. Petiole insertion in leaf of mature twig consistently marginal _____ 29

29a. Sepal more than or equal to 4 mm wide; androgynophore less than 10 mm long **21. P. parvifolium**
29b. Sepal less than 3 mm wide; androgynophore more than or equal to 10 mm **4. P. borneense p.p**.

30a. Leaf base obtuse to truncate _____ **11. P. glabrum p.p**.
30b. Leaf base oblique or subcordate to cordate _____ 31

31a. Leaf base subcordate to cordate _____ 32
31b. Leaf base oblique _____ 33

32a. Sepal more than or equal to 10 mm wide _____ **17. P. megalanthum**
32b. Sepal less than or equal to 5 mm wide _____ **25. P. sumatranum p.p**.

33a. Epicalyx bracts persistent and in conspicuous clusters _____ 34
33b. Epicalyx bracts caducous _____ **25. P. sumatranum p.p**.

34a. Petiole insertion in leaf on mature twig subpeltate _____ **8. P. elmeri p.p**.
34b. Petiole insertion in leaf of mature twig marginal _____ **20. P. obliquum p.p**.

Regional keys to Pterospermum *in Malesia*

Peninsular Malaysia and Singapore _____ I
Sumatra _____ II
Borneo _____ III
Java and the Lesser Sunda Islands _____ IV
Sulawesi and Maluku _____ V
The Philippines _____ VI

I. Peninsular Malaysia and Singapore

1a. Leaf lower surface covered with silvery fimbriate scales ____ **22. P. pecteniforme**
1b. Leaf lower surface covered with stellate or simple hairs _____ 2

2a. Leaf margin broadly toothed or broadly toothed towards apex _____ 3
2b. Leaf margin entire to repand, or sinuate _____ 5

3a. Leaf base asymmetrical; flower pedicel more than 30 mm long __**12. P. grewiifolium**
3b. Leaf base symmetrical; flower pedicel less than 20 mm long _____ 4

4a. Quaternary veins very visible on leaf lower surface; stipules persistent
1. P. acerifolium p.p.
4b. Quaternary veins faintly visible to not visible on leaf lower surface; stipules caducous
7. P. diversifolium p.p.

5a. Leaf base symmetrical _____ 6
5b. Leaf base asymmetrical _____ 8

6a. Leaf base rounded or cordate _____ 7
6b. Leaf base obtuse to truncate _____ **14. P. jackianum p.p**.

7a. Quaternary veins very visible on leaf lower surface; stipules persistent **1. P. acerifolium p.p**.
7b. Quartenary veins faintly visible to not visible on leaf lower surface, stipules caducous **7. P. diversifolium p.p**.

8a. Leaf base obtuse to truncate _____ **14. P. jackianum p.p**.
8b. Leaf base oblique to subcordate _____ **25. P. sumatranum**

II. Sumatra

1a. Leaf base symmetrical _____ **7. P. diversifolium**
1b. Leaf base asymmetrical _____ 2

2a. Leaf chartaceous _____ 3
2b. Leaf coriaceous _____ 5

3a. Fruit valve margin raised _____ 4
3b. Fruit valve margin plane _____ **15. P. javanicum**

4a. Fruit valve margin forming a flange _____ **26. P. zollingerianum**
4b. Fruit valve margin forming a rib _____ **3. P. blumeanum**

5a. Leaf basal veins 3 or fewer _____ **21. P. parvifolium**
5b. Leaf basal veins 4 or more _____ **25. P. sumatranum**

III. Borneo

1a. Leaf upper surface drying lighter in colour than the lower surface; leaf lower surface golden in colour _____ **2. P. aureum**
1b. Leaf upper surface drying same colour or darker than lower surface; leaf lower surface stramineous, fawn, tawny or chestnut-coloured _____ 2

2a. Petiole insertion subpeltate _____ **23. P. stapfianum**
2b. Petiole insertion marginal _____ 3

3a. Leaf base obtuse to truncate _____ **11. P. glabrum**
3b. Leaf base oblique or subcordate to cordate _____ 4

4a. Leaf base subcordate to cordate _____ 5
4b. Leaf base oblique _____ 9

5a. Leaf base symmetrical _____ 6
5b. Leaf base asymmetrical _____ 7

6a. Leaf chartaceous; sepal less than 70 mm long _____ **9. P. elongatum p.p**.
6b. Leaf coriaceous sepal more than 90 mm long _____ **7. P. diversifolium**

7a. Leaf chartaceous; leaf lower surface densely covered with simple hairs **9. P. elongatum p.p**.
7b. Leaf coriaceous; leaf lower surface densely covered with stellate hairs _____ 8

8a. Leaf apex truncate with a short acuminate to emarginate tip; leaf lower surface tawny **10. P. fuscum**
8b. Leaf apex acuminate to caudate; leaf lower surface stramineous to fawn **18. P. merrillianum p.p**.

9a. Flower pedicel less than 25 mm long; sepal inner surface glabrous __**13. P. havilandii**
9b. Flower pedicel more than 30 mm; sepal inner surface pubescent _ **18. P. merrillianum**

IV. Java and the Lesser Sunda Islands

1a. Leaf base symmetrical; leaf blade oblong to oblong-obovate ___ **7. P. diversifolium**
1b. Leaf base asymmetrical; leaf blade ovate to elliptic or subrhomboidal _____ 2

2a. Fruit surface persistently tomentose; sepal more than 50 mm long __ **15. P. javanicum**
2b. Fruit surface glabrescent; sepal less than 40 mm long _____ **3. P. blumeanum**

V. Sulawesi and Maluku

1a. Leaf blade oblong-obovate to oblong; fruit valve margin raised and forming flange _____ **7. P. diversifolium**
1b. Leaf blade ovate, elliptic or falcate; fruit valve margin plane _____ **5. P. celebicum**

VI. The Philippines

1a. Leaf lower surface covered with white to cream woolly hairs _____ 2
1b. Leaf lower surface covered with stramineous, fawn, tawny or chestnut-coloured woolly hairs, stellate hairs, or a combination of both _____ 3

2a. Flower pedicels less than 30 mm long _____ **19. P. niveum**
2b. Flower pedicels more than or equal to 40 mm long _____ **16. P. longipes**

3a. Leaf base symmetrical _____ 4
3b. Leaf base asymmetrical _____ 5

4a. Leaf chartaceous; sepal less than 70 mm long _____ **9. P. elongatum p.p**.
4b. Leaf coriaceous; sepal more than 90 mm long _____ **7. P. diversifolium**

5a. Leaf petiole more than or equal to 15 mm long _____ **6. P. cumingii**
5b. Leaf petiole less than 15 mm long _____ 6

6a. Epicalyx bracts persistent and in conspicuous clusters _____ 7
6b. Epicalyx bracts caducous _____ 8

7a. Flower pedicel more than or equal to 15 mm long _____ **8. P. elmeri**
7b. Flower pedicel less than or equal to 11 mm long _____ **20. P. obliquum**

8a. Leaf chartaceous _____ **9. P. elongatum p.p**.
8b. Leaf coriaceous _____ 9

9a. Petiole insertion in leaf on mature twig both marginal and subpeltate _**24. P. subpeltatum**
9b. Petiole insertion in leaf of mature twig consistently marginal _____ 10

10a. Sepal lobe more than or equal to 10 mm wide _____ **17. P. megalanthum**
10b. Sepal lobe less than or equal to 5 mm wide _____ **18. P. merrillianum**

Species descriptions

1. Pterospermum acerifolium (L.) Willd., Sp. Pl., ed. 4, 3(1): 729 (1800); de Candolle, Prodr. 1: 500 (1824); Masters in Hooker *f*., Fl. Brit. India 1(2): 368 (1874); King & Gamble, J. Asiat. Soc. Bengal, Pt 2, Nat. Hist. 60(3): 83 (1891); Ridley, Fl. Malay Penins. 1: 282 (1922); Kochummen in Whitmore, Tree Fl. Malaya 2: 368 (1973); Corner, Wayside trees Mal.: 711 (1988); Chandra in Sharma & Sanjappa, Fl. India 3: 448 (1993); Turner, Gard. Bull. Singapore 47(2): 476 (1997 [‘1995’]); Phengklai in Santisuk & Larsen, Fl. Thailand 7: 602 (2001); Tang *et al*. in Wu *et al*., Fl. China 12: 327 (2007). – *Pentapetes acerifolia* L., Sp. Pl. 2: 698 (1753). – *Pterospermadendron acerifolium* (L.) Kuntze, Rev. Gen. 1: 80 (1891) – Type: locality not known, Illustration t. 17, *in* Amman, Comment. Acad. Sci. Imp. Petrop. 8: 216 (1736) (lecto designated by Shinde *et al*., Taxon 67: 789 [2018]).

Pterospermum macrocarpum Hochr., Bull. Inst. Bot. Buitenzorg 21: 24 (1908). – Type: Indonesia, Java, Kebun Raya Bogor, 1 x 1904, *Hochreutiner* 11 (lecto NY [NY00222349], designated here; isolecto KRB, NY [NY00222350, NY00222351], P [P02286091]).

Tree to 30 m tall, 60 cm dbh, buttresses not recorded. *Outer bark* grey, rough. *New twigs* covered in tawny to chestnut-coloured hairs, becoming glabrous. *Stipules* persistent, divided into 2–5 parts, 12–20 mm long. *Leaves* alternate or spiral, internodes 5.5–10 cm long; petiole insertion peltate to occasionally marginal, petioles 20–50 mm long (up to 230 mm long in orthotropic shoots), 3–5 mm wide, covered in tawny or chestnut-coloured

hairs; blade sometimes heterophyllous (i.e. lobed and unlobed), 18–30 cm long, 14–20 cm wide, leaf length to width ratio 1–1.8, symmetrical, orbicular to oblong to obovate (palmately lobed in orthotropic shoots), margin entire or repand to occasionally broadly toothed, base symmetrical, rounded to occasionally cordate when petiole marginal, when cordate basal lobes 3–5.5 cm, apex acute to obtuse, rarely emarginate, lamina coriaceous, discolorous, upper surface chestnut-coloured, occasionally olive, glabrescent, lower surface fawn to tawny, occasionally white when new, densely covered with fawn simple woolly hairs interspersed with fawn stellate hairs; basal veins (excluding midrib) 8(–10), secondary veins (excluding basal veins) 6–9 pairs, tertiary veins clearly visible (using hand lens) on lower surface, quaternary veins clearly visible on lower surface. *Inflorescence* with up to 3 flowers in an axillary cyme; pedicels 18–20 mm long, 4–5 mm wide; epicalyx bracts usually 3, caducous, divided, c.1.8 cm long, not forming conspicuous clusters. *Flower* buds cylindrical, covered in tawny hairs. *Sepals* 110–150 mm long, c.10 mm wide, outer surface densely tomentose, yellow when fresh, drying cinnamon, inner surface sericeous. *Petals* 100–110 mm long. *Androgynophore* 30–40 mm long, c.2 mm wide, anther length not known (available anthers are damaged), c.0.5 mm wide. *Ovary* ellipsoid, c.10 mm long, c.7 mm in diameter, tomentose, styles glabrous, clavate. *Fruit* pedicel length not known, fruit sepia to black, fusiform, angular, glabrescent, large, c.15 cm long, c.6.5 cm in diameter, length to diameter ratio c.2.3; stipe present, c.6 cm long, c.2 cm in diameter, length to width ratio c.3; valve 4.5–5 mm wide, margin straight, raised and forming flange, length to valve width ratio 3–3.3. *Seeds* glabrous, 30–60 mm long (including wing), 15–17 mm wide.

Distribution. India, Bangladesh, Nepal, Bhutan, Myanmar, South China, Laos, and Thailand. In Malesia: Peninsular Malaysia as far south as the state of Selangor. This distribution pattern fits in with Corner's (1960) observation of an intrusion of Continental Asian elements into the vegetation of the Malay Peninsula extending as far south as Selangor (Fig. 7).

Habitat. Tree of alluvial, limestone, mixed dipterocarp and secondary forests.

Altitude. Between 500 and 1000 m.

Uses. Wood used for construction. The flowers of *Pterospermum acerifolium* can be eaten and have potential antidiabetic activity (Paramaguru *et al*., 2014). It is planted as an ornamental tree because of its large fragrant flowers.

IUCN conservation status. Least Concern. This species is common and widespread in its overall distribution.

Etymology. Latin, *acerifolium* = maple-like leaf.

Malesian specimens examined. MALAYSIA. **West Malaysia**: ***Kelantan***: Kuala Krai, 25 vi 1923, *Mohd. Haniff & Mohd. Nur* 10158 (KEP, SING); Bukit Tagur, 8 xi 1923, *Walton* FMS 29123 (KEP). ***Pahang***: Bentong, 20 vii 1939, *Akil* 26557 (KEP); Gunung Senyum, Base, 30 vii 1929, *Henderson* 22299 (SING); Tembeling, 29 v 1931; *Henderson* 24086 (KEP, SING); Taman Negara, S. Keniyum,

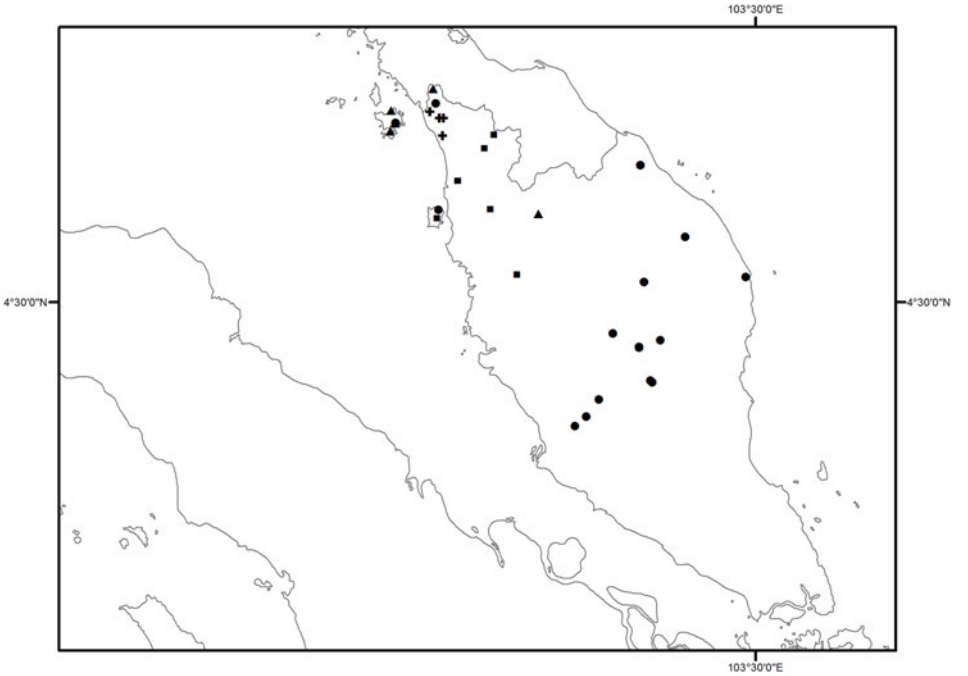

FIG. 7. Distribution of *Pterospermum acerifolium* (•), *P. grewiifolium* (▲), *P. jackianum* (■) and *P. pecteniforme* (+) in Malesia.

3 iii 1968, *Whitmore* FRI 4942 (KEP); Jerantut, Taman Negara, Gua Lias, 4 iii 1968, *Whitmore* FRI 8521 (KEP, SING); Taman Negara, along Sg Tembeling, 17 iv 1971, *Whitmore* FRI 15982 (KEP); Kuala Lipis, near Kuala Mensonn, 2 vi 1971, *Zainuddin* FRI 17885 (K, KEP, SING). ***Penang***: Penang Botanic Gardens, ix 1900, *Curtis s.n.* (SING). ***Perlis***: Bkt Ketri, 19 ix 1929, *Henderson* 22988 (KEP, SING). ***Selangor***: Batu Caves, Batu Cave Woods, x 1896, *Ridley s.n.* (SING); Ginting Simpak, 7 v 1937, *Corner* 33541 (KEP, SING). ***Terengganu***: Dungun, Sg Panchor, 16 ii 1972, *Whitmore* 20577 (KEP).

The petiole insertion of *Pterospermum acerifolium* varies from marginal to peltate. When it is marginal, the leaf base is cordate. When it is peltate, the leaf base is rounded.

This species has been confused with *Pterospermum diversifolium*. It differs in that its stipules are persistent (in *P. diversifolium* they are caducous) and that the quaternary veins on the undersurface of the leaf are clearly visible (in *P. diversifolium* they are invisible to faintly visible). Also, the stipules of *Pterospermum acerifolium* are divided (in *P. diversifolium* they are entire).

Glands near the stipules were absent from living material examined.

In this revision, *Pterospermum macrocarpum* Hochr. is considered to be a new heterotypic synonym of *P. acerifolium*. According to the protologue, *Pterospermum macrocarpum* differs from *P. acerifolium* in leaf and fruit. The leaves of *Pterospermum macrocarpum* are described as heterophyllous. However, we have found that the leaves of *Pterospermum acerifolium* are also heterophyllous. The fruit of *Pterospermum macrocarpum* is described as

being larger than that of *P. acerifolium*. However, no dimensions are given, and the types do not contain fruit. The fruit of *Pterospermum macrocarpum* is described as ovate-cylindrical in shape, which is consistent with the fruit shape of *P. acerifolium*. The fruit surface of *Pterospermum macrocarpum* is described as pubescent covered in a dense thick powdery hair. The term "powdery hair" implies that the hairs are shed, leading eventually to a glabrous surface. This is consistent with the fruit surface of *Pterospermum acerifolium*, which is glabrescent. *Pterospermum macrocarpum* was described from a tree cultivated in Bogor Botanic Gardens. The protologue gives the provenance as India, which is within the natural distribution of *Pterospermum acerifolium*.

2. Pterospermum aureum S.K.Ganesan, **sp. nov**.

Pterospermum aureum is unique among Malesian *Pterospermum* in that its leaf upper surface dries lighter in colour than the leaf lower surface. In all other Malesian *Pterospermum* the leaf upper surface dries darker in colour or is concolorous. In other characters, *Pterospermum aureum* is similar to *P. havilandii* S.K.Ganesan but differs by its leaf shape elliptic (broadly lanceolate to falcate in *P. havilandii*); leaf upper surface pubescent, drying fawn (glabrous, drying sepia in *P. havilandii*). – Type: Malaysia, Sarawak, 4th Division, Gunung Api, 27 ix 1971, *Anderson* S.307737 (holo L [L.3969978]; iso E [E00533433]), K). **Fig. 8**.

Height and dbh unknown, buttresses not recorded. *Outer bark* unknown. *New twigs* covered in chestnut-coloured hairs, becoming glabrous. *Stipules* caducous, entire, lanceolate, 8.5–10.6 mm long, c.1.7 mm wide. *Leaves* alternate, internodes 1.5–2 cm long; petiole insertion marginal, petioles 7–10 mm long, 1.3–2 mm wide, covered in golden hairs; blade not lobed, 4.6–7.6 cm long, 2.8–3.5 cm wide, leaf length to width ratio 1.6–2.2, symmetrical, elliptic, margin repand, base asymmetrical, oblique to subcordate, when subcordate basal lobes c.0.1 cm, apex cuspidate to caudate; lamina coriaceous, discolorous, upper surface drying lighter in colour than lower surface, fawn, pubescent (hairy on midrib and on secondary veins near intersection with midrib), lower surface golden, densely covered with golden woolly simple hairs; basal veins (excluding midrib) 3 or 4, secondary veins (excluding basal veins) 3 pairs, tertiary veins not visible (using land lens) on lower surface, quaternary veins not visible on lower surface. *Flowers* unknown. *Fruit* pedicels 1–1.3 cm long, 3–6 mm wide, fruit chestnut-coloured, cylindrical, terete, glabrescent, c.12.7 cm long, diameter unknown (fruit dehisced), length to diameter ratio unknown; stipe absent; valve c.2.2 cm wide, margin straight and plane, length to valve width ratio c.5.8. *Seeds* unknown.

Distribution. Known only from the type collection at Gunung Api, Sarawak (Fig. 9).

Habitat. Evidently restricted to limestone.

Altitude. At c.1000 m.

Uses. The attractive golden undersurface of the leaf offers horticultural potential.

IUCN conservation status. Data Deficient (DD). More information is needed to assess the population size and and full geographical extent.

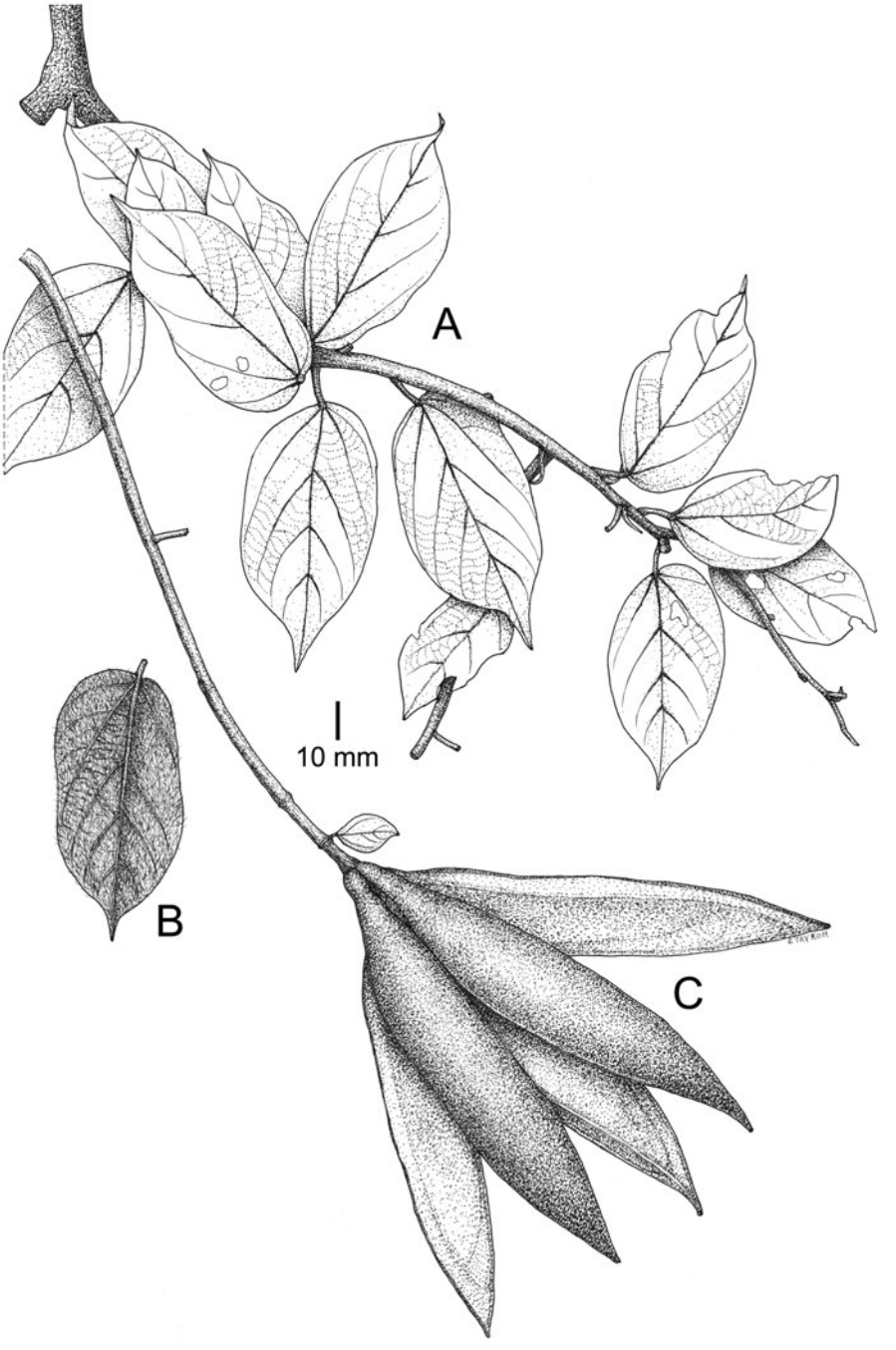

FIG. 8. *Pterospermum aureum* S.K.Ganesan, sp. nov. (*Anderson* S.307737 [L]). A, Twig; B, leaf lower surface; C, fruit. Drawing by Evonne Koh.

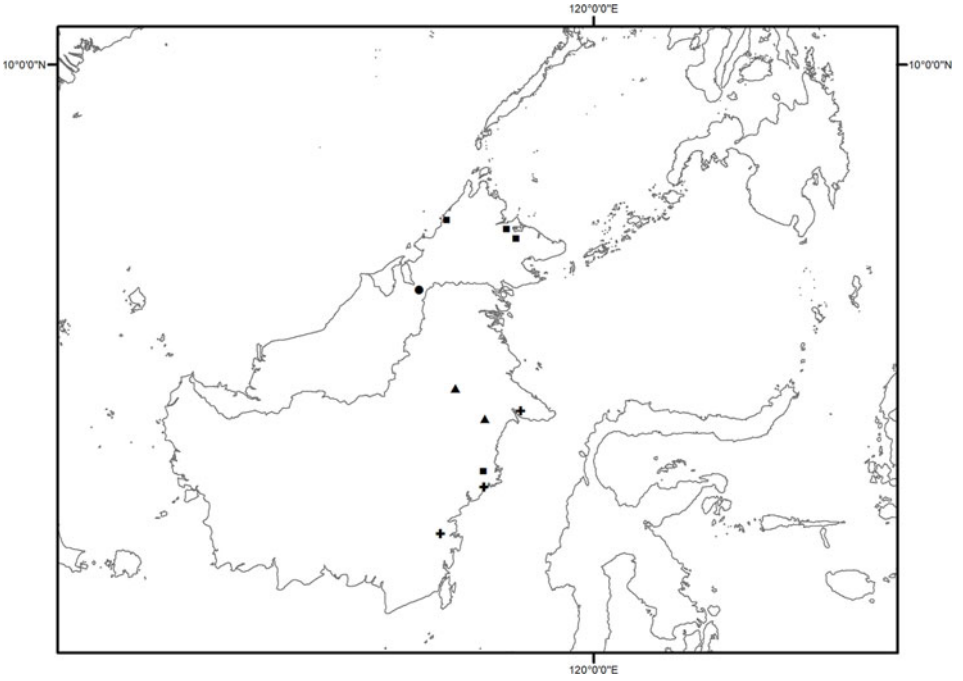

FIG. 9. Distribution of *Pterospermum aureum* (•), *P. borneense* (■), *P. fuscum* (+) and *P. glabrum* (▲) in Malesia.

Etymology. Latin, *aureum* = after the golden-coloured undersurface of the leaf.

Malesian specimen examined. MALAYSIA. **East Malaysia**: ***Sarawak***: 4th Division, Gunung Api, 27 ix 1971, *Anderson* S.307737 (holo L [L.3969978]; iso E [E00533433], K).

3. Pterospermum blumeanum Korth., Ned. Kruidk. Arch. 1: 311 (1848). – Type: Indonesia, Java, 1835, *Blume s.n*. (lecto P [P02286090], designated here).
Pterospermum lanceifolium auct. non Roxb.: Blume, Bijdr. Fl. Ned. Ind. 2: 87 (1825).

Large tree to 35 m tall, 100 cm dbh, buttresses present. *Outer bark* light brown, smooth to rough. *New twigs* covered in white to tawny hairs, becoming glabrous. *Stipules* caducous, entire, subulate, 3.6–4.5 mm long, 0.8 mm wide. *Leaves* alternate, internodes 1–2.5 cm long; petiole insertion marginal, petioles 5–7 mm long, 0.8–1.2 mm wide, covered in stramineous hairs; blade not lobed, 4–6.9 cm long, 2–3.4 cm wide, leaf length to width ratio 2–2.5, asymmetrical, subrhomboidal to occasionally ovate, margin entire to repand, base asymmetrical, oblique, apex acuminate; lamina chartaceous, discolorous, upper surface tawny to chestnut-coloured, glabrous, lower surface stramineous to tawny, densely covered in fawn-coloured simple woolly hairs interspersed with fawn-coloured stellate hairs; basal

veins (excluding midrib) 2 or 3, secondary veins (excluding basal veins) 4 (or 5) pairs, tertiary veins faintly visible on lower surface, quaternary veins not visible on lower surface. *Inflorescence* with 1 or 2 flowers in axillary cyme; pedicels 10–17 mm long, 0.8–1.5 mm wide; epicalyx bracts fugaceous, not seen, not forming conspicuous clusters. *Flower* buds lanceolate, covered in stramineous hairs. *Sepals* 29–39 mm long, 2.5–3.3 mm wide, outer surface densely tomentose, yellow when fresh, drying stramineous to tawny, inner surface woolly. *Petals* 25–31 mm long. *Androgynophore* 1.8–2.5 mm long, 1.5–1.8 mm wide, anther 5.3–6.2 mm long, c.0.3 mm wide. *Ovary* ovoid, 3.3–4.2 mm long, c.2.7 mm in diameter, tomentose, styles hairy on lower half, clavate. *Fruit* pedicel length and width unknown (fruits available are detached), fruit sepia to black, fusiform, ribbed, glabrescent, 10 cm long, diameter unknown (fruits available are dehisced), fruit length to diameter ratio not known; stipe absent; valve c.1.8 cm wide, valve margin straight, raised and forming a rib, length to valve width ratio c.5.5. *Seeds* glabrous, c.42 mm long (including wing), c.4 mm wide.

Distribution. Sumatra, Java, Bali and Lombok (Fig. 10).

Habitat. Primary and secondary forests, occasionally occurring over limestone.

Altitude. Between 0 and 500 m.

Uses. For timber.

IUCN conservation status. Endangered B2ab(ii,iii,v) (Ganesan, 2017a).

Etymology. Latin, *blumeanum* = after Blume, Carl Ludwig (1796–1892), German-born Dutch botanist.

Malesian specimens examined. INDONESIA. **Bali**: Kg Sawoe, vi 1958, *Kostermans* et al. SS 343 (BO, K, SING). **Java**: ***Banten***: Peutjang Island, Udjung Kulon Reserve, vii 1960, *Kostermans & Kuswata* 28 (BO, K, SING); Pulau Peutjang, ii 1959, *Sinclair* 9998 (K, SING); Ujung Kulon Nature Reserve, viii 1972, *de Vogel* 1570 (K, L). ***Central Java***: Kedoengdjati, iv 1888, *Koorders* 7793β (FHO, L); Soebah, x 1891, *Koorders* 11612 (L); Noesa Kambangan, ix 1895, *Koorders* 20100 (L); Ngarengan, v 1899, *Koorders* 33645 (L); Pekalongan, v 1899, *Koorders* 36776 (L). ***East Java***: Besuki, Blambangan, v 1957, *Jacobs* 4960 (K, L, SING); Besoeki, ix 1889, *Koorders* 7819 (L); Blambangan, *s.d*., *Hasskarl s.n*. (L); Djampangkulon, vii 1890, *Koorders* 7791 (L); Djember, x 1933, *Boschproefstation* Ja 2709 (L); Gadoengan, vi 1896, *Koorders* 22983 (L); Gedeh, xii 1918, *Ladage s.n*. (L); Kangean, 1954, *Hoogerwerf s.n*. (L); Kediri, x 1918, *Grutterink* 3107 (L); Pandan, x 1892, *Koorders* 7813 (L); Poeger, vii 1889, *Koorders* 7816 (L); Rogodjampi, viii 1889, *Koorders* 7832 (L); Toeloeng, viii 1923, *Wind* 6556 (L). ***Jakarta***: Batavia, iv 1920, *Bakhuizen van den Brink Jr* 4902 (L). ***West Java***: Buitenzorg, xii 1923, *Bakhuizen van den Brink Jr* 6069 (K, L); Pandeglang, v 1933, *Boschproefstation* Ja 2641 (L); Panaitan, ix 1951. *van Borssum Waalkes* 565 (L); Sanggrawa, vii 1890, *Koorders* 7792 (L); Tjibodas, v 1923, *Bakhuizen van den Brink Jr* 2689 (L). **Lombok**: West Lombok, Batoekoembong, v 1931, *Boschproefstation*. bb 15492 (BO, K, SING). **Sumatra**: ***South Sumatra***: 1881, *Forbes* 1657 (L [3], SING); Lampong, Tangga, viii 1928, *de Voogd* 154 (L).

Pterospermum blumeanum was considered by Koorders & Valeton (1895) to be a synonym of *P. javanicum*. It differs, however, from *Pterospermum javanicum* in that its fruit are

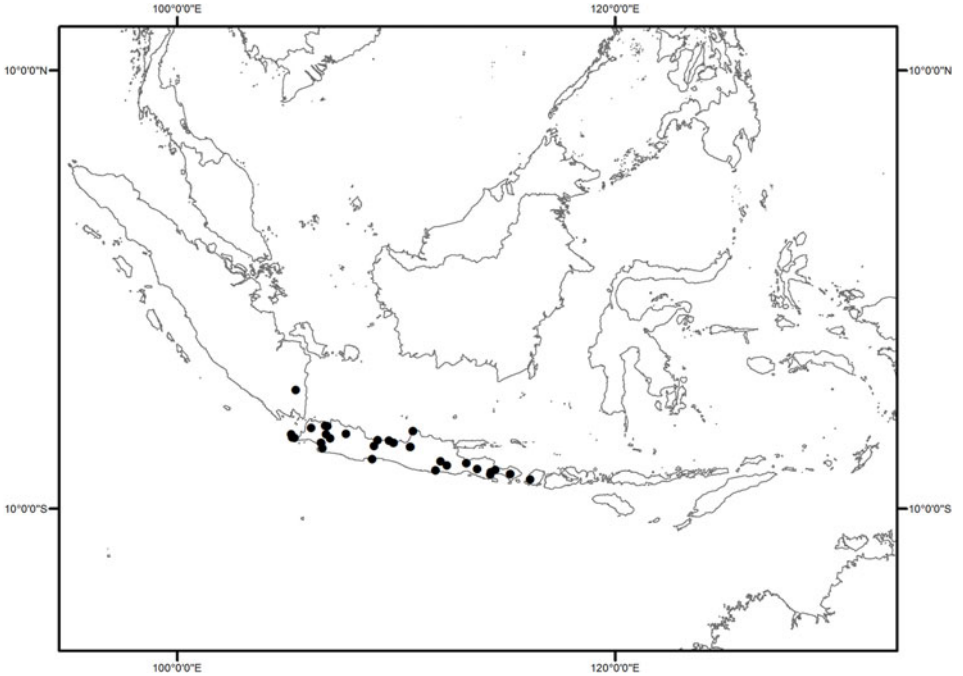

FIG. 10. Distribution of *Pterospermum blumeanum* in Malesia.

glabrescent, its sepals are shorter and narrower (29–39 mm long, 2.5–3.3 mm wide) and it occurs at lower altitudes (below 500 m). In *Pterospermum javanicum* the fruit is persistently tomentose, sepals 60–65 mm long and 6–7 mm wide, and it occurs above 600 m in altitude.

4. Pterospermum borneense S.K.Ganesan, **sp. nov**.

Pterospermum borneense resembles *P. javanicum* Jungh., but *P. borneense* has coriaceous leaves (not chartaceous), narrower sepals (1.5–1.9 mm versus 6–7 mm wide), a longer androgynophore (12 mm versus 4.2 mm long) and a longer fruit pedicel (6–7 cm versus c.3.5 cm long). *Pterospermum borneense* is also similar to *P. merrillianum* S.K.Ganesan but has narrower leaves (2.7–3 cm versus 3.8–5.2 cm wide) and sepals (1.5–1.9 mm versus 2.8–5 mm wide). – Type: Indonesia, East Kalimantan, East Kutei, Loa Haur, 15 v 1952, *Kostermans* A 6936 (holo L [L.3969809]; iso BO, K, SING [SING 0218220]). **Fig. 11**.

Tree to 28 m tall, 50 cm dbh, buttresses not recorded. *Outer bark* dark brown, texture not known. *New twigs* covered in tawny hairs, becoming glabrous. *Stipules* caducous, entire, filiform, 6 mm long, 0.3 mm wide. *Leaves* alternate, internodes 1–1.2 cm long; petiole insertion marginal, petioles 6–8 mm long, 1–1.6 mm wide, covered in fawn-coloured hairs;

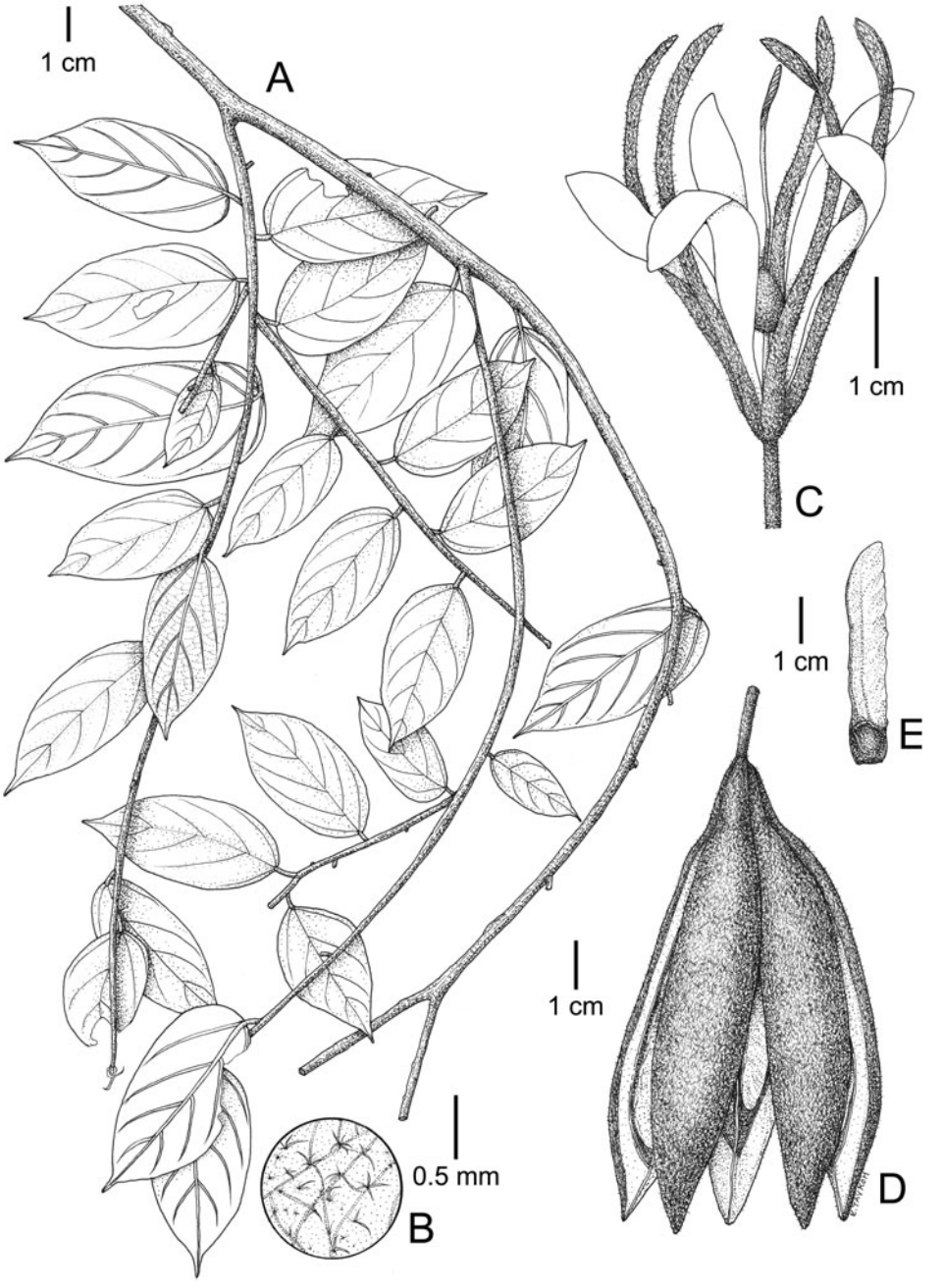

FIG. 11. *Pterospermum borneense* S.K.Ganesan, sp. nov. A, Twig (*Kostermans* A 6936 [SING]); B, hairs on leaf lower surface (*Kostermans* A 6936 [SING]); C, flower (*Mujin* SAN 33687 [SING]); D, fruit (*Kostermans* A 6936 [SING]); E, seed (*Kostermans* A 6936 [SING]). Drawing by Evonne Koh.

blade not lobed, 6–8 cm long, 2.7–3 cm wide, leaf length to width ratio 2.2–2.7, asymmetrical, lanceolate to occasionally falcate, margin repand, base asymmetrical, oblique, apex acuminate; lamina coriaceous, discolorous, upper surface olive to tawny, glabrous, lower surface tawny, densely covered with fawn-coloured stellate hairs; basal veins (excluding midrib) (3 or) 4, secondary veins (excluding basal veins) 3 or 4 pairs, tertiary veins faintly visible on lower surface, quaternary veins obscure on lower surface. *Inflorescence* of a solitary, axillary flower; pedicels 22–45 mm long, 1 mm wide; epicalyx bracts 3, caducous entire, filiform, 6–10 mm long, 1–1.2 mm wide, not forming conspicuous clusters. *Flower* buds oblong, covered in chestnut-coloured hairs. *Sepals* c.46 mm long, 1.5–1.9 mm wide, outer surface densely stellate hairy, cinnamon, inner surface woolly. *Petals* 30–45 mm long. *Androgynophore* c.12 mm long, c.0.6 mm wide, anther length unknown, width unknown. *Ovary* ellipsoid, c.7 mm long, c.4 mm in diameter, tomentose, styles hairy at base, clavate. *Fruit* pedicels 6–7 cm long, 2–3 mm wide, fruit tawny, fusiform, terete, indumentum persistent and tomentose, 10–12 cm long, width unknown (fruit dehisced), length to width ratio unknown; stipe absent; valve 1.8–2.1 cm wide, margin straight and plane, length to width ratio 5.6–5.7. *Seeds* glabrous, 47–56 mm long (including wing), 9–11 mm wide.

Distribution. Endemic to Borneo, where it has been collected in Sabah and East Kalimantan (see Fig. 9).

Habitat. Roadside, sandy poor soils, loam soil, wet ground.

Altitude. Between 0 and 500 m.

Uses. None recorded.

IUCN conservation status. Endangered B2ab(i,ii,ii). The extent of occurrence (EOO) of this species is 66,594 km^2 and the area of occupancy (AOO) is 16 km^2 based on specimen data but up to 100 km^2 based on potential available habitat. For this assessment, we take the higher estimation, which is still below the AOO threshold for the Endangered (EN) category under criterion B. The most serious plausible threat affecting individuals of this species is habitat loss through deforestation and subsequent conversion of forest to oil palm plantations. Imagery from Google Maps (no date) reveals widespread deforestation within the EOO. It is likely that the majority of the population of this species does not share genetic material with the main population, owing to severe fragmentation. Therefore, the population is severely fragmented, fulfilling subcriterion a. Although some individuals may be within protected areas, deforestation in other areas is likely to continue and this fulfils subcriteria b(i), (ii) and (iii) (continuing decline observed, estimated, inferred or projected in: i, the EOO; ii, the AOO; and iii, the extent and/or quality of habitat). The species is therefore listed here as Endangered.

Etymology. Latin, *borneense* = from Borneo.

Malesian specimens examined. INDONESIA. **East Kalimantan**: Loa Haur, 15 v 1952, *Kostermans* A 6936 (holo L; iso BO, K, SING).

MALAYSIA. **East Malaysia**: ***Sabah***: Kinabatangan, Mananggul, Bkt Garam, iii 1987, *George* et al. SAN 117694 (E, K, KEP, L, SING); Tuaran, Lema'as Forest Reserve, iv 1963, *Mujin* SAN 33687 (KEP, L, SING); Sandakan, Elopura, i 1948, *Yap* A711 (KEP, SING).

5. Pterospermum celebicum Miq., Illustr. Fl. Arch. Ind. 2: 87 (1870). – Type: Indonesia, Sulawesi, North Sulawesi, Relang [Belang], x 1840, *Forsten* 323 (lecto L [L.0012782], designated here; isolecto BO, L [L.0012780, L.0012781, L.0062820]).

Tree to 12 m tall, 25 cm dbh, buttresses not recorded. *Outer bark* grey to brown, smooth. *New twigs* covered in tawny to chestnut-coloured hairs, becoming glabrous. *Stipules* caducous, entire, subulate, 3.3–5.7 mm long, c.0.8 mm wide, stipular glands present. *Leaves* alternate, internodes 1.5–2 cm long; petiole insertion marginal to occasionally subpeltate, petioles 5–10 mm long, 1.6–1.7 mm wide, covered in tawny hairs; blade unlobed, 6.2–13.5 cm long, 3.5–6 cm wide, length to width ratio 1.7–2.3, asymmetrical to occasionally symmetrical, ovate, elliptic or falcate, margin entire to repand, base asymmetrical, oblique to subcordate, occasionally subpeltate, when subcordate basal lobes c.0.5 cm, when subpeltate 0.5–0.6 cm from point of insertion to base of leaf, apex acute to acuminate; lamina chartaceous, discolorous, upper surface sepia, glabrous, lower surface tawny, densely covered with fawn-coloured short woolly simple hairs with interspersed stellate hairs; basal veins (excluding midrib) 3–5, secondary veins (excluding basal veins) 5 or 6 pairs, tertiary veins visible on lower surface, quaternary veins visible on lower surface. *Inflorescence* of up to 2 flowers in an axillary cyme; pedicels 9–17 mm long, 0.8–1.2 mm wide; epicalyx bracts 3, caducous to rarely persistent, entire, subulate, 3–5.2 mm long, 0.7–2.3 mm wide, not forming conspicuous clusters. *Flower* buds oblong, covered in tawny to chestnut-coloured hairs. *Sepals* 45–55 mm long, 2.5–3.5 mm wide, outer surface densely woolly, fawn or yellow when fresh, drying fuscous, inner surface woolly. *Petals* 32–40 mm long. *Androgynophore* 7–9 mm long, 0.8–1 mm wide, anthers 4.1–4.6 mm long, 0.3 mm wide. *Ovary* ellipsoid, 4.2–5 mm long, c.2.5 mm in diameter, woolly, styles hairy at base, clavate. *Fruit* pedicel length and width unknown (fruits available are detached), fruit chestnut-coloured to black, fusiform to oblong, terete, glabrescent 8–9 cm long, c.2.7 cm in diameter, length to fruit diameter ratio c.3.3; stipe absent; valve 1.3–1.5 cm wide, margin straight and plane, length to valve width ratio c.6.1. *Seeds* glabrous, 35–45 mm long (including wing), 8–9 mm wide.

Distribution. Endemic to Eastern Indonesia, where it is found in Sulawesi, Maluku and the Talaud Islands (Fig. 12).

Habitat. Depleted primary forests, secondary forests, riverine forests.

Altitude. Between 0 and 1000 m.

Uses. Timber for construction.

IUCN conservation status. Least Concern (Ganesan, 2017b).

Etymology. Latin, *celebicum* = from the island of Celebes, now known as Sulawesi.

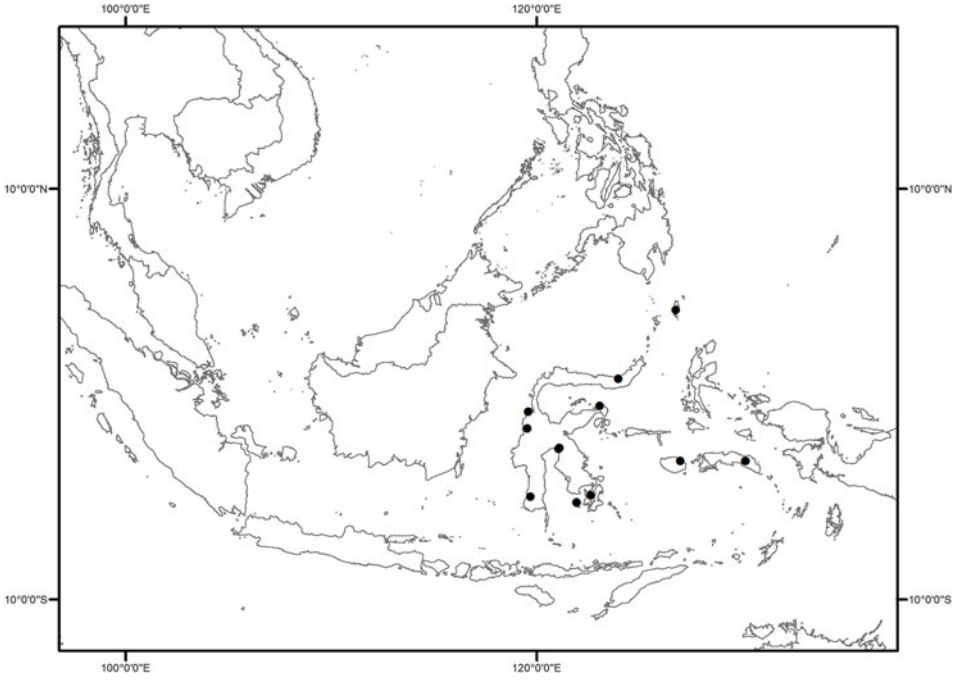

FIG. 12. Distribution of *Pterospermum celebicum* in Malesia.

Malesian specimens examined. INDONESIA. **Maluku**: Buru, Buru N.W., Wae Duna River, xi 1984, *van Balgooy* 4881 (KEP); Buru, Balo, vii 1938, *Boschproefstation* 25186 (BO); Soela Sanana, viii 1939, *Bloembergen* 4496 (SING). **Sulawesi**: ***Central Sulawesi***: Kamorora, Palolo, Lore Lindu NP, 21 v 2001, *Ramadhanil* et al. 301 (BO, K). ***North Sulawesi***: Ameorang, i 1933, *Boschproefstation* bb 17287 (BO); Manado, Donggalo, iii 1934, *Boschproefstation* bb 18665 (BO); Rolalaan Mongondo, x 1973, *de Vogel* 2588 (BO). ***South Sulawesi***: Saloeng, x 1923, *Boschproefstation* 27 (BO); Muna, Laboenti, x 1922, *Boschproefstation* bb 4191 (BO, K [2],); Batimurung, vii 1966, *Kostermans* et al. 1 (BO); Wasalangka, viii 1936, *Neth. Ind. For. Service* bb. 21339 (K); Raha (Moena), *s.d.*, *Waturandang* 213 (BO); Malili, vi 1934, *Neth. Ind. For. Service* 329 (SING); Kolaka Area, x 1989, *Coode* 6062 (K); Kabaena Island, vii 1993, *McDonald & Ismail* 4004 (BO, K, KEP, SING); South-West Sulawesi, Makassar, Karenta Cove, vii 1976, *Meijer* 10872 (BO). **Talaud**: Karakelang, 14 v 1926, Lam 3009 (BO, SING).

Pterospermum celebicum is very similar to *P. niveum* but differs in that its leaf lower surface is tawny and its flower buds are oblong whereas in *P. niveum* the leaf lower surface is white to cream and flower buds are ovate.

In most specimens of *Pterospermum celebicum* the epicalyx bracts are shed before the flower opens. However, in *McDonald & Ismail* 4004 (BO), the epicalyx bracts are found with open flowers.

Glands at the base of stipules have been observed in living material of this species.

Forsten 323 at L consists of five duplicates. The sheet with barcode L.0012782 is chosen as the lectotype, because it contains flowers that are most clearly visible and contains the most label information.

The type locality ought to be Belang, not Relang as stated in the protologue. Relang is not found in the GEOnet Names Server (no date), and the collector (Forsten) and date of collection (December 1840) correspond to the locality of Belang in van Steenis-Kruseman (1950). On one of the type sheets (L.001782), 'Belang' is visible. It is therefore very likely that 'Belang' has been misprinted as 'Relang' in the protologue.

6. Pterospermum cumingii Merr. & Rolfe, Philipp. J. Sci., C 3: 113 (1908); Merrill, Enum. Philipp. Fl. Pl. 3: 49 (1923). – Type: Philippines, 1841, *Cuming* 1860 (holo K [K000671871], iso A).

Pterospermum rubiginosum auct. non Heyne ex G.Don.: Fernandez-Villar, Nov. App. 28 (1880).

Small tree to 6 m tall, dbh not recorded, buttresses not recorded. *Outer bark* not recorded. *New twigs* covered in stramineous to chestnut-coloured hairs, becoming glabrous. *Stipules* caducous, entire, ensiform to filiform, 4–9.6 mm long, 0.6–1.3 mm wide. *Leaves* alternate, internodes 0.5–2 cm long; petiole insertion marginal, petioles relatively long, 15–23 mm, 1–1.9 mm wide, covered in stramineous to occasionally white hairs; blade not lobed, 4–12.3 cm long, 2.3–7.5 cm wide, length to width ratio 1.7–2.5, symmetrical, elliptic to obovate, occasionally ovate, margin repand, base slightly asymmetrical, oblique to subcordate, when subcordate basal lobes 0.08–0.16 cm, apex acuminate; lamina chartaceous, discolorous, upper surface chestnut-coloured, glabrescent, lower surface tawny, densely covered with fawn-coloured simple woolly hairs interspersed with larger chestnut-coloured stellate hairs; basal veins (excluding midrib) 4, secondary veins (excluding basal veins) 4 or 5 (or 6) pairs, tertiary veins visible on lower surface, quaternary veins not visible on lower surface. *Inflorescence* of 1 or 2 axillary flowers per cyme; pedicels 3.2–4 mm long, 1.8–1.9 mm wide; epicalyx bracts 3, persistent, gland absent, entire, lanceolate, relatively long, 6.4–7.2 mm, 1.3–1.7 mm wide, not forming conspicuous clusters. *Flower* buds lanceolate, covered in chestnut-coloured hairs. *Sepals* 20–21 mm long, 1.9–2.6 mm wide, outer surface densely stellate hairy, cinnamon in colour, inner surface sericeous. *Petals* 17–19 mm long. *Androgynophore* c.3 mm long, c.2.2 mm wide, anthers c.4 mm long, c.0.2 mm wide. *Ovary* globose, 4.2–5.1 mm long, 3.7–4 mm in diameter, tomentose, style hairy on lower half, clavate. *Fruit* pedicels 1–1.3 cm long, 2 mm wide, fruit chestnut-coloured, fusiform to occasionally cylindrical in shape, terete, persistently tomentose, relatively small 3.3–4 cm long, diameter unknown (all fruits seen have dehisced), length to fruit diameter ratio not known; stipe present, 0.4–0.5 cm long, 0.50–0.8 cm in diameter, length to stipe diameter ratio 0.63–0.8; valve 0.9–1.2 cm wide, margins straight and plane, length to valve width ratio 3.3–3.7. *Seeds* glabrous 17–30 mm long (including wing), 5.6–8 mm wide.

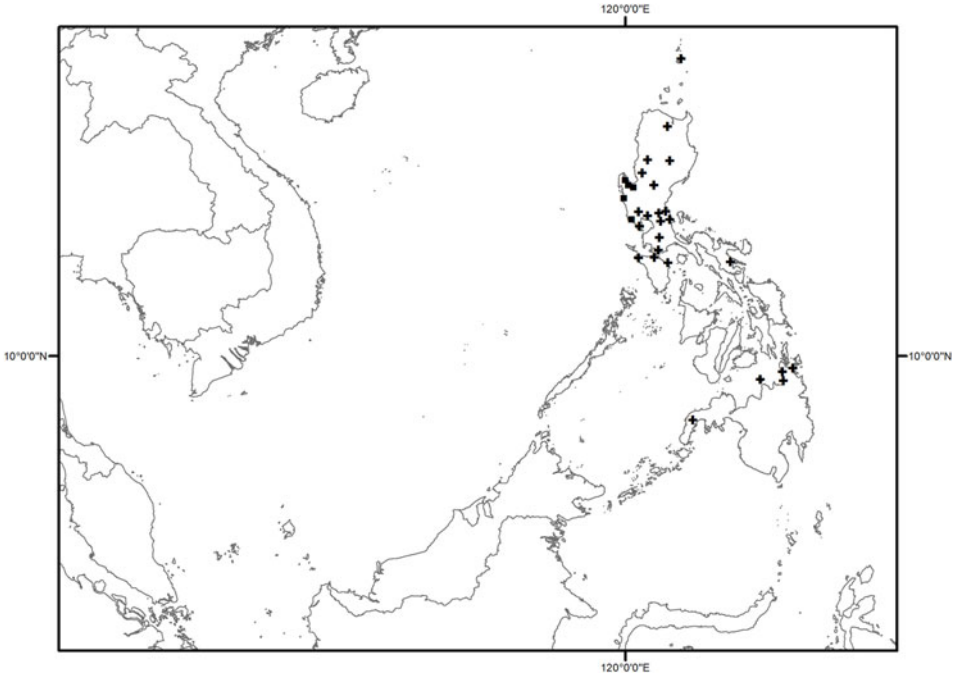

FIG. 13. Distribution of *Pterospermum cumingii* (■) and *P. niveum* (+) in Malesia.

Distribution. Endemic to the Philippines (Fig. 13). Found only in the western part of Luzon (Pangasinan and Zambales Provinces).

Habitat. Forests on ultramafic soil. The distribution of *Pterospermum cumingii* corresponds with the Zambales Ophiolite Complex (Michaux, 2010), which includes mafic and ultramafic rocks. The label of *Wilkie* 99275 (E) states that the specimen grew on ultramafic soil, and therefore it is highly probable that *Pterospermum cumingii* is an ultramafic endemic.

Altitude. Between 0 and 750 m.

Uses. There is a possibility that this species may have a high tolerance of heavy metals, and the potential exists for it be used in the restoration of lands affected by mining for heavy metals.

IUCN conservation status. Endangered B1ab(iii,iv,v)+2ab(iii,iv,v) (Ganesan, 2017c).

Etymology. Latin, *cumingii* = after Hugh Cuming (1791–1865), English naturalist.

Malesian specimens examined. PHILIPPINES. **Luzon**: ***Pangasinan***: Alaminos, x 1922, *McGregor* 41428 (A, BO, SING); Mansiloc, 13 xi 1999, *Wilkie* et al. 99225 (E); Mansinloc, 15 xi 1999, *Wilkie* et al. 99275 (A, E); Mt San Isidro, Labrador, xi 1917, *Fenix* 29942 (A, NY). ***Zambales***: Grande Island, Subic Bay, 28 ii 1970, *Beuchamp* 1110 (A).

Pterospermum cumingii is similar to *P. diversifolium* but differs in that its leaf base is slightly asymmetrical and its fruit do not have flanges whereas the leaf base of *P. diversifolium* is symmetrical and the fruit has flanges.

7. Pterospermum diversifolium Blume, Bijdr. Fl. Ned. Ind. 2: 88 (1825); Miquel, Fl. Ned. Ind. 1(2): 192 (1859); Masters in Hooker *f.*, Fl. Brit. India 1(2): 367 (1874); King & Gamble, J. Asiat. Soc. Bengal, Pt 2, Nat. Hist. 60(3): 84 (1891); Gagnepain in Lecomte, Fl. Indo-Chine 1: 500 (1910); Ridley, Fl. Malay Penins. 1: 22 (1922); Merrill, Enum. Philipp. Fl. Pl. 3: 49 (1923); Koorders & Valeton, Bijdr. Boomsoort. Java 2: 185 (1895); Backer & Bakhuizen *f.*, Fl. Java 1: 409 (1964); Kochummen in Whitmore, Tree Fl. Malaya 2: 368 (1973); Corner, Wayside trees Mal.: 710 (1988); Turner, Gard. Bull. Singapore 47(2): 476 (1997 ['1995']); Chandra in Sharma & Sanjappa, Fl. India 3: 449 (1993); Wilkie in Argent *et al.*, Manual Non-Dipterocarp Trees Central Kalimantan 2: 610 (1997); Phengklai in Santisuk & Larsen, Fl. Thailand 7: 604 (2001); Wilkie & Berhaman in Soepadmo *et al.*, Tree Fl. Sabah Sarawak 7: 370 (2011); Ganesan, Nature in Singapore 6: 149 (2013). – Type: Indonesia, Java, *s.d.*, *Blume s.n.* (lecto K [K000671873], designated by Wilkie & Berhaman in Soepadmo *et al.*, Tree Fl. Sabah Sarawak 7: 370 [2011]).

Pterospermum hastatum Blanco, Fl. Filip. 528 (1837); Merrill, Sp. Blancoan. 260 (1918). – Type: Philippines, Luzon, Batangas, Mt Apayang, 25 vii 1914, *Ramos s.n.* (Merrill: Species Blancoanae No. 533) (neo US [US00604328], designated here; isoneo NY).

Pterospermum acerifolium auct. non. Willd.: Rolfe, J. Bot. 23: 211 (1885); Vidal, Revis. Pl. Vasc. Filip. 67 (1886).

Tree to 20 m tall, 60 cm dbh, buttresses present. *Outer bark* fawn, rough. *New twigs* covered in stramineous to fawn hairs becoming glabrous. *Stipules* caducous, entire, 4–13 mm long, 2–3 mm wide, triangular. *Leaves* alternate or spiral, internodes 1–3.2 cm long; petiole insertion marginal (subpeltate in orthotropic shoots), petioles 10–45 mm long (to 250 mm long in orthotropic shoots), 2–3.8 mm wide, covered in stramineous to fawn-coloured hairs; blade sometimes heterophyllous, 9.5–28 cm long, 6–14.5 cm wide, length to width ratio 1.4–2.1, symmetrical, oblong-obovate to oblong (palmately lobed in orthotropic shoots), margin repand, occasionally broadly toothed near apex, base symmetrical, cordate, basal lobes 0.5–3.3 cm, apex cuspidate; lamina coriaceous, discolorous, upper surface chestnut-coloured, glabrescent, lower surface stramineous to tawny, occasionally white when new; basal veins (excluding midrib) (4–)6(–8), secondary veins (excluding basal veins) 7–9(–10) pairs, tertiary veins clearly visible on lower surface, quaternary veins not visible to faintly visible on lower surface. *Inflorescence* of solitary axillary flowers; pedicels relatively short, 4.8–8 mm long, 3–5.1 mm wide; epicalyx bracts 3, caducous, entire, subulate, 2–4.5 mm long, 2 mm wide, not forming conspicuous clusters. *Flower* buds oblong, covered in tawny hairs. *Sepals* 100–150 mm long, 4–8 mm wide, outer surface densely stellate hairy, drying a fawn colour, inner surface sericeous. *Petals* 80–140 mm long. *Androgynophore* 35–50 mm long, 1.6–2.9 mm wide, anthers 15–18 mm long, 0.4–0.6 mm wide. *Ovary*

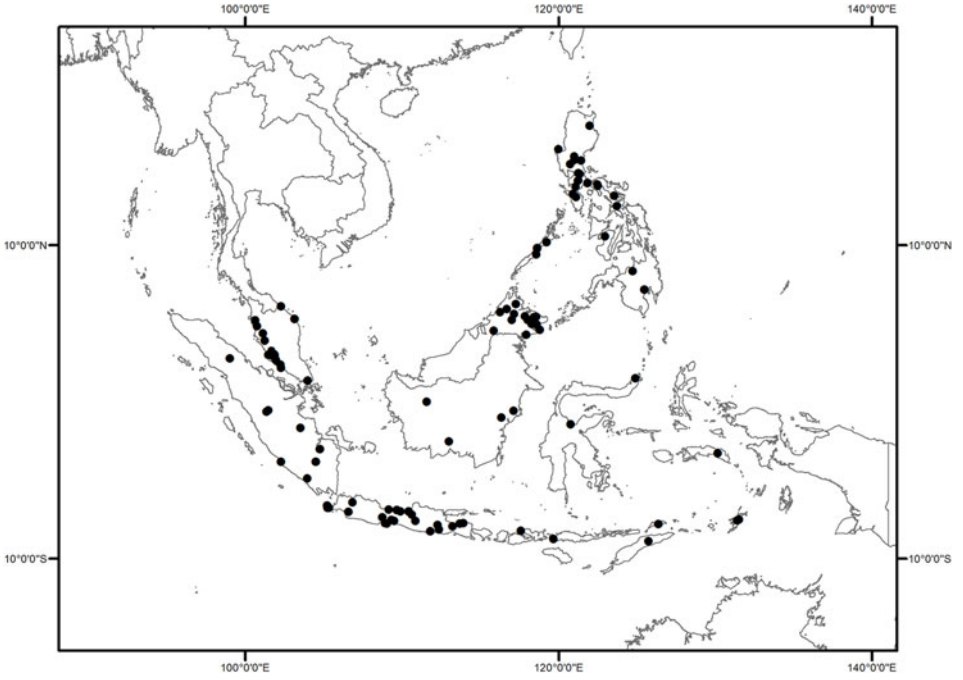

FIG. 14. Distribution of *Pterospermum diversifolium* in Malesia.

ellipsoid, 6–10 mm long, 3–5 mm in diameter, tomentose, style hairy on lower half, clavate. *Fruit* pedicels 4–6.5 cm long, 4–11 cm wide, fruit sepia, falcate to oblong, angular, glabrescent, 5–14 cm long, 1.1–4.5 cm in diameter, length to fruit diameter ratio 2–2.3; stipe present, 0.7–2 cm long, 0.6–1.5 cm in diameter, length to diameter ratio 1.2–1.3; valve 1.5–3.5 cm wide, margin straight, raised and forming a flange, length to valve width ratio 3.3–4.7. *Seeds* glabrous, 19–44 mm long (including wing), 6–14 mm wide.

Distribution. India, Burma, Thailand and Indochina (Cambodia, Laos and Vietnam). In Malesia recorded from West Malaysia, Singapore, Sumatra, Java, Borneo (Sabah, Central, East and West Kalimantan), Sulawesi, Sumbawa, Maluku and the Philippines (Luzon, Leyte, Palawan, Tical, Mindoro and Mindanao) (Fig. 14).

Habitat. Tree of riverside and secondary forests.

Altitude. Between 0 and 1000 m.

Uses. The wood is used for construction. The bark is used to obtain a yellow dye.

IUCN conservation status. Least Concern (LC). This species is common and widespread.

Etymology. Latin, *diversifolium* = diverse leaf.

Malesian specimens examined. INDONESIA. **Flores**: W. Flores, Komodo, Mt Arab, x 1961, *Muktar* 25 (K). **Java**: ***Banten***: Udjung Kulon Nature Reserve, iii 1964, *Kostermans s.n.* (L). ***Central Java***:

Banjoemas, 17 ix 1896, *Koorders* 24557 (FHO, L); Doerentoempang, 8 viii 1929, *Boschproefstation* Ja 1902 (L); Kedoengdjati, 12 iv 1888, *Koorders* 7764β (L); Madjenang, 17 i 1915, *Backer* 18507 (L); Noesa Kambangan, 5 x 1891, *Koorders* 7768β (L); Semarang, 15 i 1924, *Vincent* 4698a (L); Sempor, 2 vi 1936, *Brinkman* 716 (L); Soebah, 5 vi 1893, *Koorders* 13467β (L); Solo, 22 v 1888, *Koorders* 7767β (L); Tegal, 7 ix 1891, *Koorders* 7769 (L); Tjilatjap, Koebang Kangkoeng, 4 vi 1935, *Boschproefstation*, JA 3535 (L). ***East Java***: Besoeki, 10 vi 1889, *Koorders* 7782 (L); Poeger, 10 x 1889, *Koorders* 7780 (L); Popoh, 6 i 1929, *Coert s.n.* (K); Wonoredjo, 6 iii 1931, *Boschproefstation*, Ja 2259 (L). ***West Java***: Depok, 16 vii 1922, *Bakhuizen van den Brink Jr.* 5617 (L); Panaitan, SE of Mt Tjiharashas, 3 ix 1951, *van Borssum Waalkes* 305 (L); Palaboeanratoe, 25 iv 1893, *Koorders* 12247β (L). ***Yogyakarta***: Baronbaai, 23 viii 1922, *Burger* 2092 (L); Goendil, 28 vi 1931, *Clason-Laarman* Fc/5 (L); Ngrenean Bay, 22 ix 1922, *Burger* 2167 (L); Tlawah, Solo, 22 v 1888, *Koorders* 7765 (BO, L). **Kalimantan**: ***Central Kalimantan***: Sg Mentaya above Sampit, 9 v 1993, *Argent* et al. 93111 (E, L). ***East Kalimantan***: Antjabeng, Central East Borneo, W. Koetai, no. 9 near Mt Antjaloeng, 17 vii 1925, *Endert* 2085 (L [2]); East Kutai, xi 1934, *Boschproefstation* bb 19277 (L); Kahayan, Kamp Dawi, 10 xi 1920, *Mondi* 2471 (L); Lahoem, W. Koetai, 30 vii 1925, *Endert* 1784 (L [2]). ***West Kalimantan***: Melawi, 10 x 1939, *Neth. Ind. For. Service* bb 29622 (L). **Maluku**: Tanimbar Islands, Jamdena, 5 iv 1956, *van Borssum Waalkes* 3293 (SING); Wetar, Ilwaki, 11 v 1939, *Neth. Ind. For. Service* bb 27251 (SING); Sula, Weg Samoeja, N. Parigi, 23 x 1939, *Neth. Ind. For. Service* bb 29950 (SING). **Sulawesi**: ***Central Sulawesi***: Poso, Ceedele, 11 ii 1940, *Neth. Ind. For. Service* bb 31494 (SING). ***North Sulawesi***: Manado, Palos, 13 vii 1933, *Neth. Ind. For. Service* bb 17627 (SING). **Sumatra**: ***Aceh***: 5 ii 1890, *Koorders* 10572β (L). ***Bengkulu***: Kebanagoeng, 18 i 1932, *de Voogd* 1205 (L). ***Jambi***: x 1994, *Kerlogue s.n.* (E). ***Lampung***: Way Pesang, x 1921, *de Wit* 3 (L). ***North Sumatra***: Kerasahan, 11 ix 1941, *Simandjoentak* bb 32991 (L); Serdang, Plantage Gallia, 19 xi 1928, *Lörzing* 14600 (L); Sibolga, Pontjang Ketjil, 7 x 1957, *Dali* 196 (L); Simalungun, 26 x 1922, *Boschproefstation* bb 4905 (L). ***Riau***: Belimbing, 9 vii 1939, *Boschproefstation* bb 28586 (L). ***South Sumatra***: Kommering-Ilir, 29 iv 1918, *Endert* 319 (L); Palembang, *Praetorius s.n.* (L); Ranau Lake, xii 1927, *de Voogd* 59 (L).

MALAYSIA. **East Malaysia**: ***Sabah***: Tawau, 28 ix 1962, *Aban* SAN 31347 (KEP); Kinabatangan, Sg Menanggul, 12 xi 1983, *Amin*, et al. 66011 (KEP, L, SING); Lahad Datu, Semporna, Bubul State Forest, 26 ix 1947, *Harvey* 143 (KEP, SING); Sandakan, Ganduman F. Res., 13 ix 1975, *Lantoh* 82342 (SING); Sandakan, Elopura, Kretam Besar, 18 iii 1948, *Anthony* 762 (SING); Telupid, Kg Wasai, 8 ix1997, *Salat* SD 19 (KEP); Tenom, Tomani, Jalan Ulu Tomani, 22 v 1964, *Masirum Rundi* SAN 43189 (L); Tongod, Tobobon, Mt Trusmadi, 1983, *Marabini* 4 (L); Ranau, Along Sg Mankadan, near Sungai Takutan, 22 v 1973, *Shea & Aban* 77136 (L, SING). **West Malaysia**: ***Johor***: Buloh Kasap, 7 vii 1936, *Corner s.n.* (SING). ***Kedah***: Langkawi, xi 1968, *Keng* et al. K 6215 (SING). ***Kelantan***: Kota Bahru, Kuala Terengganu, 2 v 1937, *Corner s.n.* (SING). ***Kuala Lumpur***: Kampong Baru, 11 iv 1919, *Ahmad* CF 3048 (KEP, SING). ***Melaka***: Alor Gajah, Panchor, Panchor Rd, i 1894, *Goodenough* 1729 (SING); Batu Tiga, xi 1892, *Derry* 1170 (SING). ***Negeri Sembilan***: Mantin Pass, 33 3/4 miles on main Kuala Lumpur Road, 13 xi 1953, *Sinclair* SFN 40165 (KEP, SING); Seremban, 7 vii 1936, *Corner* 31507 (SING). ***Perak***: Hilir Perak, Changkat Jong, 7 ix 1967, *Ng* FRI 5622 (SING); Larut, iv 1884, *King's collector* 5977 (SING); Kinta River, ix 1885, *King's collector* 8160 (L, SING,). ***Selangor***: Gombak, Ampang Rd, 11 iv 1926, *Abdul Majid* FMS 11621 (KEP, L); Gombak, Ulu Gombak, 16 Mile, U.M. field Studies Centre, 12 xi 1965, *Stone* 6063 (L, SING); Klang, Klang road, Kampong Puchong, at 13 mile Klang Rd, 17 xi 1965, *Kassim & Mahmud* 697 (L, SING); Hulu Langat, Sg Lalang FR, 15 iii 930, *Symington* FMS 22849 (KEP); Puchong, at 13 mile Klang Rd, 17 xi 1965, *Unknown* 697 (KEP, SING); Hulu Langat, Bkt Janking, 18 x 1959, *Gadeh anak Umbai & Millard* 1837 (K, KEP, L, SING). ***Terengganu***: Kuala Terengganu, 27 iv 1937, *Corner s.n.* (SING); Kuala Terengganu, Kampung Ladang, 13 v 1925, *Holttum* 17679 (SING).

PHILIPPINES. **Leyte**: Hubasan, Visca, 23 iii 1993, *Gaerlan* et al. PPI 10518 (KEP). **Luzon**: ***Albay Province***: *s.d.*, *Cuming* 1052 (E). ***Neuva Ecija Province***: x 1940, *Alvarez* 22121 (E); Cabanatuan, xii

1927, *Clemens* 17680 (SING). ***Quezon Province***: Tayabas, Guinayangan, iv 1903, *Merrill* 2037 (SING). ***Rizal Province***: Bosoboso, vii 1903, *Merrill* 2820 (SING). **Mindanao**: ***Davao Province***: Davao, vi 1919, *de Mesa* 27628 (SING). **Palawan**: Puerto Princesa, ii 1923, *Cenabre* 29205 (KEP); Puerto Princesa, iii 1911, *Elmer* 12840 (E); Lake Manguao, 7 iv 1984, *Ridsdale* SMHI 361 (KEP); Aborlan, Iraan Mountains, vi 1950, *Sulit* 12521 (SING).

Singapore. Pulau Ubin, 5 iii 1890, *Ridley* 387 (SING); Pulau Ubin, xii 2007, *Ali Ibrahim* et al. SING 2007-416 (SING); Pulau Ubin, 17 x 2012, *Ganesan* et al. SKG251 (SING).

Timor-Leste. *s.d.*, *Boorsma* 598 (BO).

Pterospermum diversifolium is similar to *P. acerifolium* but differs in that its stipules are entire (divided in *P. acerifolium*) and that the quaternary veins on the lower surface of the leaf are not visible to faintly visible (clearly visible in *P. diversifolium*).

Stilt roots are recorded on the field label of *Sugau* JBS 84 (SAN) from Keningau, Crocker Range, Sabah. This is exceptional, because it is the only record of the occurrence of stilt roots in Malesian *Pterospermum*. This specimen may represent a new species, but we do not have sufficient material to describe it as such.

We agree with Merrill (1918) that the description in the protologue of *Pterospermum hastatum* Blanco fits that of *P. diversifolium* Blume, in particular, Blanco's description of the leaves as "acorazonadas" (Spanish for heart-shaped). *Pterospermum diversifolium* is the only species of *Pterospermum* in the Philippines that has a heart-shaped leaf. Therefore, *Pterospermum hastatum* is here accepted as a synonym of *P. diversifolium*.

It is widely accepted that Blanco did not preserve his specimens (Merrill, 1918), and we have not found any *Pterospermum* specimens collected by him. We have followed the established approach (e.g. Veldkamp, 1989; Nicolson & Arculus, 2001) of neotypifiying Blanco's species by designating the relevant material in Merrill's Species Blancoanae in the US as the neotype of *Pterospermum hastatum* Blanco.

8. Pterospermum elmeri Merr., Philipp. J. Sci., C 7: 304 (1912); Merrill, Enum. Philipp. Fl. Pl. 3: 49 (1923). – Type: Philippines, Mindanao, Todaya, Mount Apo, x 1909, *Elmer* 11928 (lecto NY [NY00222346], designated here; isolecto A, E [E00533448], GH [GH00039566], K, US [US00102198, US01013658]).

Tree to 8 m tall, 31 cm dbh, buttresses not recorded. *Outer bark* not known. *New twigs* covered in fawn-coloured hairs becoming glabrous. *Stipules* caducous, entire, filiform, c.5 mm long, c.0.8 mm wide. *Leaves* alternate, internodes 2 cm long; petiole insertion subpeltate, petioles 3–4 mm long, c.1.7 mm wide, covered in fawn-coloured hairs; blade not lobed, 6–25 cm long, 3.2–8.5 cm wide, length to width ratio 1.9–2.9, asymmetrical, ovate, margin repand, base asymmetrical, oblique, depth of base 0.5–1.5 cm (from point of insertion to base of leaf), apex acuminate; lamina coriaceous, discolorous, upper surface chestnut-coloured to sepia, late glabrescent, lower surface tawny, densely covered with fawn-coloured, simple, woolly hairs interspersed with fawn-coloured stellate hairs; basal veins (excluding midrib) 2–4, secondary veins (excluding basal veins) 5 or 6, tertiary veins visible on lower surface, quaternary veins not visible on lower surface. *Inflorescence* of more than one axillary flower per cyme; pedicels c.25 mm long, c.1 mm wide; epicalyx

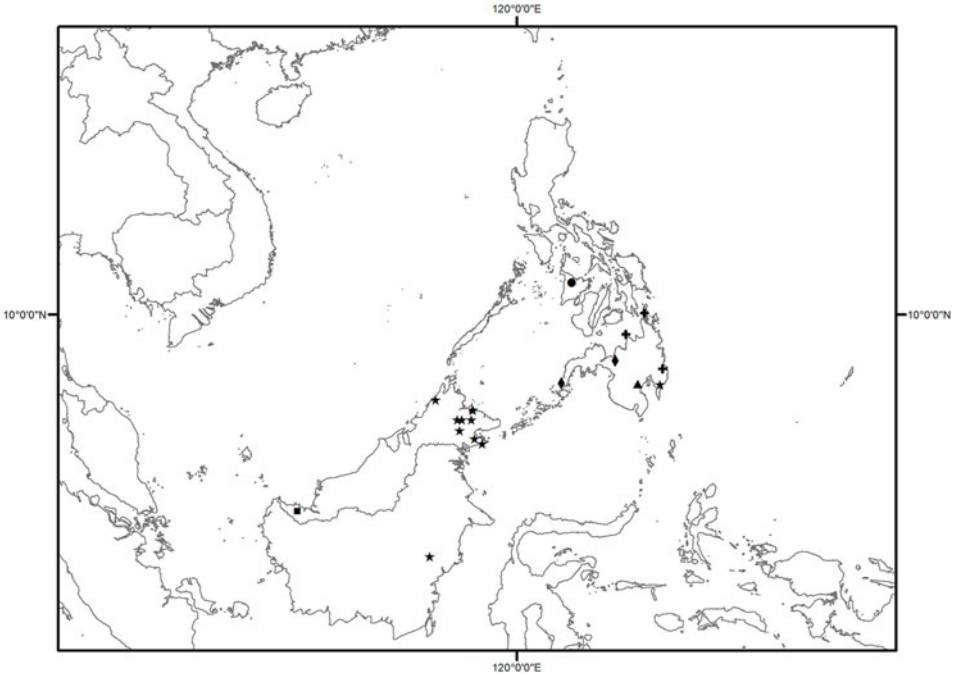

FIG. 15. Distribution of *Pterospermum elmeri* (▲), *P. havilandii* (■), *P. longipes* (+), *P. megalanthum* (•), *P. merrillianum* (★) and *P. subpeltatum* (♦) in Malesia.

bracts about 5, persistent, divided, trifid, c.10 mm long, c.1.2 mm wide, forming conspicuous clusters. *Flower* buds ovate, covered in tawny hairs. *Sepals* 32–38 mm long, c.3 mm wide, outer surface densely stellate hairy, outer surface drying cinnamon, inner surface strigose. *Petals* c.30 mm long. *Androgynophore* c.6.7 mm long, c.0.7 mm wide, anthers c.6.7 mm long, 0.3–0.4 mm wide. *Ovary* globose, c.3.8 mm long, c.3.4 mm in diameter, tomentose, style hairy at base, clavate. *Fruit* not known. *Seeds* not known.

Distribution. Mindanao and Samar in the Philippines (Fig. 15).

Habitat. According to the specimen labels, it is found in open woodland at 750 m.

Altitude. At about 750 m.

Uses. None recorded.

IUCN conservation status. Critically Endangered (Possibly Extinct) B1ab(iii)+2ab(iii) (Ganesan, 2017d).

Etymology. Latin, *elmeri* = after Elmer, Adolph Daniel Edward (1870–1942), collector of the type.

Malesian specimens examined. PHILIPPINES. **Mindanao**: Todaya, Mt Apo, x 1909, *Elmer* 11928 (A, E, GH, K, NY, US). **Samar**: iii 1914, *Ramos* 17513 (K).

Pterospermum elmeri is most similar to *P. obliquum*, but the leaves of *P. elmeri* are ovate whereas those of *P. obliquum* are lanceolate to falcate.

The syntype from NY (NY000346) is selected as the lectotype because it best matches the description in the protologue.

9. Pterospermum elongatum Korth., Ned. Kruidk. Arch. 1: 312 (1848); Shea in Cockburn, Trees of Sabah 1: 237 (1976); Wilkie in Argent *et al*., Man. Non-Dipterocarp Trees Central Kalimantan 2: 610 (1997); Wilkie & Berhaman in Soepadmo *et al*., Tree Fl. Sabah Sarawak 7: 372 (2011). – Type: Indonesia, South Kalimantan, Banjarmasin, Doesoen, along Kapuas River, *s.d*., *Korthals s.n*. (lecto L [L.3969996], designated by Wilkie & Berhaman in Soepadmo *et al*., Tree Fl. Sabah Sarawak 7: 372 [2011]); isolecto NY [NY00222347]).

Pterospermum perrinii Elmer, Leafl. Philipp. Bot. 5: 1840 (1913); Merrill, Enum. Philipp. Fl. Pl. 3: 51 (1923). – Type: Philippines, Palawan, Puerto Princesa, Mt Pulgar, iii 1911, *Elmer* 12841 (lecto K [K00671864], designated here; isolecto A [A00039567], BISH [BISH1005108], E [E00273772], HBG [HBG512372], L [L.0614102], NY [NY00222352], U [0111917], US [US01013655, US00102202]).

Large tree to 35 m tall, 50 cm dbh, buttresses present. *Outer bark* pale grey, grey-brown or light brown, texture not recorded. *New twigs* covered in tawny hairs becoming glabrous. *Stipules* caducous, dissected, subulate, 0.8–3.5 mm long, 10 mm wide. *Leaves* alternate, internodes 1.1–3.5 cm long; petiole insertion marginal, petioles 5–9 mm long, 1.5–2 mm wide, covered in tawny hairs; blade unlobed, 7.2–14 cm long, 4–7 cm wide, length to width ratio 1.7–2.5, symmetrical, ovate to oblong, margin repand, base symmetrical to slightly asymmetrical, subcordate to occasionally cordate, basal lobes 0.1–0.6 cm, apex acute to occasionally acuminate; lamina chartaceous, discolorous, upper surface chestnut-coloured to sepia, glabrous, lower surface tawny to chestnut-coloured, occasionally white when new, densely covered with chestnut-coloured to fawn simple woolly hairs; basal veins (excluding midrib) 4, secondary veins (excluding basal veins) 5–7 pairs, tertiary veins visible on lower surface, quaternary veins not visible on lower surface. *Inflorescence* of up to 3 axillary flowers per cyme; pedicels 35–40 mm long, 1 mm wide; epicalyx bracts 3, caducous, entire, subulate, c.7 mm long, c.2.5 mm wide, not forming conspicuous clusters. *Flower* buds cylindrical, covered in chestnut-coloured hairs. *Sepals* 50–55 mm long, 3–4 mm wide, outer surface densely stellate hairy, yellow when fresh, drying cinnamon, inner surface strigose. *Petals* 35–42 mm long. *Androgynophore* 8.5–11 mm long, 0.6–1 mm wide, anthers c.5.5 mm long, c.3 mm wide. *Ovary* ovoid, c.5.2 mm long, c.3.5 mm in diameter, tomentose, style glabrous, clavate. *Fruit* pedicels 4–6 cm long, 0.15–0.2 mm wide, fruit chestnut-coloured to occasionally sepia, cylindrical to obovoid, terete, glabrescent, 6.5–11.5 cm long, 22–35 mm in diameter, length to width ratio 2.6–3.3; stipe absent; valve 2–3.5 cm wide, margin straight and plane, length to width ratio 2.7–3.3. *Seeds* glabrous 20–50 mm long (including wing), 10–12 mm wide.

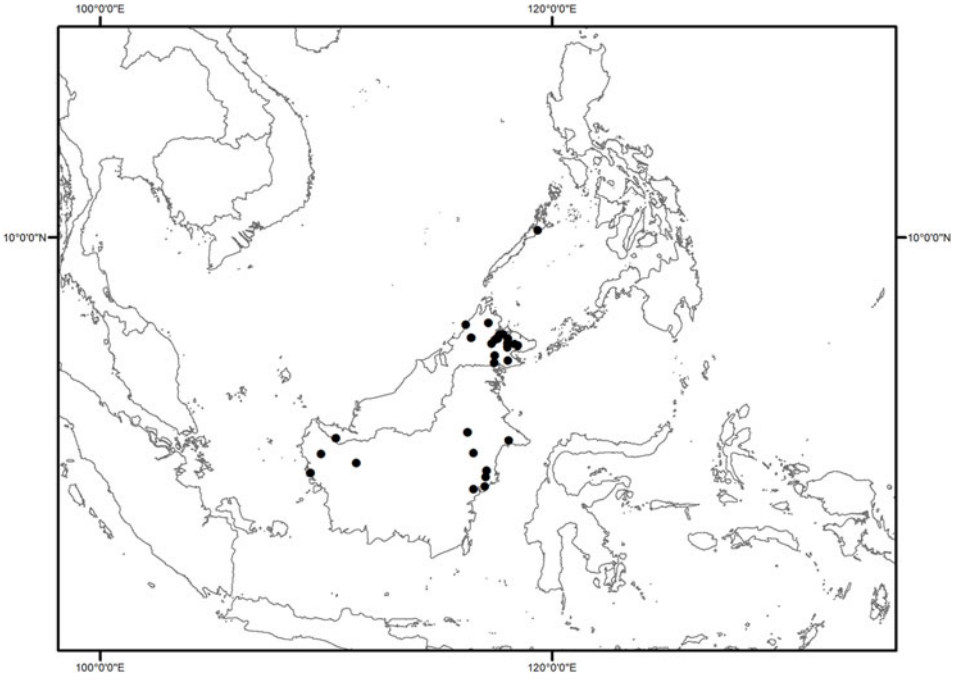

FIG. 16. Distribution of *Pterospermum elongatum* in Malesia.

Distribution. Borneo (Sabah, Sarawak, South Kalimantan) and the Philippines (Palawan) (Fig. 16). Contrary to Wilkie & Berhaman (2011), this species has not been recorded from Brunei.

Habitat. Secondary and mixed dipterocarp forests, occasionally on alluvium.

Altitude. Between 0 and 500 m.

Uses. Timber for construction.

IUCN conservation status. Least Concern (Ganesan, 2017e).

Etymology. Latin, *elongatum* = long, tapering; exact inference not known, possibly referring to the fruits in the type specimen.

Malesian specimens examined. INDONESIA. **East Kalimantan**: Ampar, 2 x 1991, *Ambriansyah & Arifin* AA 188 (BO, L); Ancalong, 21 vii 1925, *Endert* 2158 (L); Berau, 9 v 1934, *Boschproefstation* bb 18809 (L); Berau, 12 v 1934, *Boschproefstation* bb 18900 (L); East Kutei, 10 xii 1930, *Boschproefstation* bb 14693 (L); Kalioerang, 31 v 1951, *Kostermans* 4934 (L); Leban, 10 xii 1930, *Boschproefstation* bb 14693 (L); Loa Haur, 9 v 1952, *Kostermans*. 6817 (BO, L, SING); Mandanai, 13 x 1921, *Boschproefstation* bb 2636 (L); Sangkulirang, 31 v 1951, *Kostermans* 4934 (SING); Soeharto, 27 xii 1994, *Ambriansyah & Arbainsyah* AA 986 (BO, L). **West Kalimantan**: Ambawang, *Boschwezen* 2123 (L); Landak, *s.d.*, *Teijsmann s.n.* (L); Nanga Betung, 10 x 1939, *Boschproefstation* bb 29622 (L).

MALAYSIA. **East Malaysia**: ***Sabah***: Kota Belud, Templer Forest Reserve, 17 ix 1972, *Shea Minjulu* SAN 76150 (L); Lahad Datu, Taliwas, 28 xi 1963, *Agam Ambullah* SAN 37227 (L); Ulu Segama Forest Reserve, 2 v 1980, *Patrick Lassan* SAN 92078 (KEP, L); Ranau, 8 v 1973, *Shea & Aban* 76846 (SING); Takutan, 29 v 1973, *Shea & Gibot* SAN 77254 (L); Pinawantai, 8 v 1973, *Shea & Gibot* SAN 76846 (L); Bettotan, 28 iii 1935, *Puasa* BNBFD 4552 (L); Dagat, 12 vii 1987, *George* et al. SAN 120717 (L); Elopura, Segaliud, 4 v 1950, *Kadir* 2777 (L, SING); Gomantong Forest Reserve, 7 vii 1963, *Ahwing James* SAN 38195 (L); Gum-Gum, 4 viii 1981, *Amin Gambating* SAN 92900 (L); Kabili, 7 vi 1963, *Sam* SAN 37527 (L); Kota Belud, 17 ix 1972, *Shea & Minjulu* 76150 (SING); Kretam, 7 v 1953, *Sam* A 1879 (L [2]); Lungmanis camp, 9 viii 1962, *Mikil* SAN 31576 (L); Sapagaya Forest Reserve, 15 v 1949, *Cuadra* A 2268 (L); Sepilok Forest Reserve, 13 v 1957, *Kadir Abdul* A 3518 (K, KEP, L, SAN, SING); Tawau, Kelumpang Balong, 12 viii 1961, *Bakar* SAN 18523 (SING); Tawau, Quoin 15.5 mile Hill Road, 28 ix 1962, *Gibot* SAN 31347 (L). ***Sarawak***: 4th Division: Ulu Gedong, 17 iv 1935, *Wright* 563 (KEP).

PHILIPPINES. **Palawan**: San Vicente, Roxas, 30 iii 1990, *Soerjarto & Madulid* 7199 (A, BO).

Pterospermum elongatum is morphologically similar to *P. stapfianum*, and their close relationship is supported by molecular evidence (Ganesan, 2016). *Pterospermum stapfianum* differs from *P. elongatum* by having adult leaves that are consistently subpeltate.

Glands at the base of stipules have been observed in living material of this species.

Pterospermum perrinii Elmer is newly placed in synonymy with *P. elongatum*, because we found no distinction between them.

The specimen from K (K00671864) is selected as lectotype for *Pterospermum perrinii*, because its flowers are in the best condition.

10. Pterospermum fuscum Korth., Ned. Kruidk. Arch. 1: 312 (1848). – Type: Indonesia, South Kalimantan, Near Banjermassing, *Korthals s.n.* (original material not found; presumed lost or destroyed). Neotype: Indonesia, East Kalimantan, W. Koetai, 24 xi 1925, *Endert* 5212 (neo L [L.3969986], designated here; isoneo BO, K, SING).

Tree to 40 m tall, 50 cm dbh, buttresses present. *Outer bark* pale grey-brown, rough. *New twigs* covered in tawny hairs, mature twigs with patches of tawny hairs. *Stipules* caducous, entire, filiform, c.9.1 mm long, c.0.1 mm wide. *Leaves* alternate, internodes 2.2–3.5 cm long; petiole insertion peltate, petioles 7–12 mm long, 2.3–4.2 mm wide, covered in tawny hairs; blade unlobed, 9.2–18 cm long, 6–11.5 cm wide, length to width ratio 1.5–1.6, asymmetrical, oblong to ovate, occasionally obovate, margin repand, base asymmetrical, cordate, basal lobes 0.5–2.7 cm, apex truncate with a short, acuminate to emarginate tip; lamina chartaceous, discolorous, upper surface chestnut-coloured, pubescent (patches of tawny hairs), lower surface tawny, densely covered with tawny stellate hairs; basal veins (excluding midrib) 4, secondary veins (excluding basal veins) 4 or 5 pairs, tertiary veins clearly visible on lower surface, quaternary veins visible on lower surface. *Inflorescence* of up to 3 axillary flowers in a cyme; pedicels 15–25 mm long, c.0.2 mm wide; epicalyx bracts 3, caducous, entire, subulate to filiform, c.6 mm long, c.0.1 mm wide, not forming conspicuous clusters. *Flower* buds ellipsoid, covered in fuscous hairs. *Sepals* 5, c.40 cm long, 3.5–4.2 mm wide, outer surface densely tomentose, drying chestnut-coloured, inner surface woolly. *Petals* c.30 mm long. *Androgynophore* c.4.2 mm long, c.1.3 mm wide,

anther length not known (all anthers available are damaged), width c.0.2 mm. *Ovary* ellipsoid, c.5 mm long, 3.5 mm in diameter, woolly, style glabrous, clavate. *Fruit* capsule, five-angled, densely furfuraceous tomentose (not seen, description from Korthals, 1848). *Seeds* not known.

Distribution. Endemic to Borneo, where it has been collected in East and South Kalimantan (see Fig. 9).

Habitat. Low flat country, on loam soil and limestone rock.

Altitude. Below 500 m.

Uses. None recorded. However, the attractive lower surface of the leaves offers potential for cultivation as an ornamental.

IUCN conservation status. Endangered B2ab(i,ii,iii,v) (Ganesan, 2017f).

Etymology. Latin *fuscum* = darkened, referring to the darkened lower surfaces of the leaf.

Malesian specimens examined. INDONESIA. **East Kalimantan**: Sangkulirang, iv 1931, *Boschproefstation* bb 15212 (L); Sangkulirang, iv 1931, *Boschproefstation* bb 15251 (L); Sangkulirang, iv 1931, *Boschproefstation* bb 15252 (L); West Kutai, *s.d.*, *Boschproefstation* bb 16160 (L); West Kutai, xi 1925, *Endert* 5212 (K, L); West Kutai, xii 1931, *Ned. Ind. For. Service* bb 16178 (L). **South Kalimantan**: Pangelah, xi 1929, *Boschproefstation* bb 13858 (L).

This species is similar to *Pterospermum sumatranum*. However, *Pterospermum fuscum* differs in that its leaf upper surface is pubescent and it has a truncate leaf apex with a short, acuminate to emarginate tip whereas the leaf upper surface of *P. sumatranum* is glabrescent and the leaf apex is acuminate.

This species has not been mentioned in the literature since its publication by Korthals (1848), and no specimens have been found that have been determined as this species.

According to van Steenis-Kruseman (1950), Korthals' specimens from Borneo are in BO and L. We have searched both these collections but have not been able to find original material. Therefore, a neotype is designated.

11. Pterospermum glabrum S.K.Ganesan, **sp. nov**.

Pterospermum glabrum resembles *P. longipes* Merr. by its glabrous fruits, a character otherwise unknown among Malesian *Pterospermum* species. *Pterospermum glabrum* differs from *P. longipes* in that its leaf lower surface is tawny and covered in minute stellate hairs whereas that of *P. longipes* is white to cream and covered in woolly simple hairs. – Type: Indonesia, East Kalimantan, Berau, 2 x 1995, *Ambriansyah* 786 (holo L [L.3969588], iso SING). **Fig. 17**.

Tree to 40 m tall, 40 cm dbh, buttresses not recorded. *Outer bark* grey to light-brown, rough. *New twigs* covered in chestnut-coloured hairs, becoming glabrous. *Stipules*

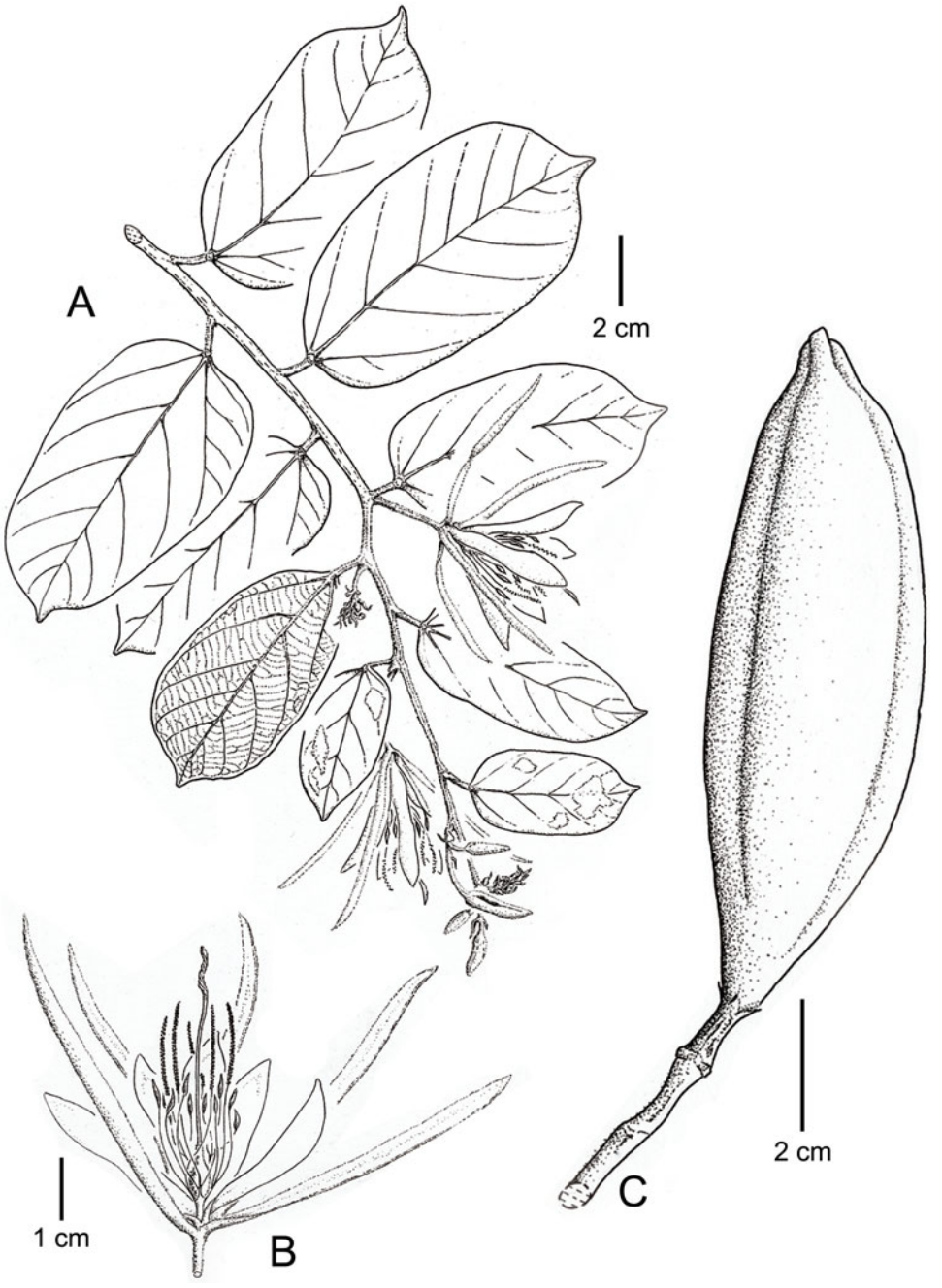

FIG. 17. *Pterospermum glabrum* S.K.Ganesan, sp. nov. A, Twig (*Ambriansyah* et al. 786 (L) and *Kostermans* 2158 [L]); B, flower (*Kostermans* 21528 [L]); C, fruit (*Ambriansyah* et al. 786 [L]). Drawing by Rebecca Camfield.

caducous, entire, lanceolate, 7–8.4 mm long, c.2 mm wide. *Leaves* alternate, internodes 1.7–2.2 cm long; petiole insertion marginal, petioles 6–11 mm long, 1.3–2 mm wide, covered in tawny to occasionally whitish hairs; blade not lobed, 6.1–10 cm long, 2.9–5 cm wide, length to width ratio 1.5–2.6, symmetrical, oblong to elliptic, rarely obovate, margin entire to repand, base slightly asymmetrical to asymmetrical, obtuse to truncate, apex cuspidate; lamina coriaceous, discolorous, upper surface sepia, glabrescent, lower surface tawny, densely hairy covered with minute stellate hairs; basal veins (excluding midrib) 3 or 4, secondary veins (excluding basal veins) 5 or 6 pairs, tertiary veins very visible to visible on lower surface, quaternary veins not visible to faintly visible on lower surface. *Inflorescence* of solitary terminal or axillary flowers; pedicels c.15 mm long, 1.2–1.5 mm wide; epicalyx bracts early caducous, number and morphology not known, not forming conspicuous clusters. *Flower* buds lanceolate, covered in chestnut-coloured hairs. *Sepals* 50–55 cm long, 1.7–2 mm wide, outer surface densely stellate hairy, drying cinnamon, inner surface woolly. *Petals* 35–37 mm long. *Androgynophore* c.5.8 mm long, c.1.2 mm wide, anthers 4.2–4.3 mm long, c.0.3 mm wide. *Ovary* ellipsoid, c.5 mm long, c.2.8 mm wide, tomentose, style hairy at base, clavate. *Fruit* pedicels 5–5.5 cm long, c.2 mm wide, sepia, cylindrical, furrowed, glabrous, c.10 cm long, c.2.7 cm in diameter, length to diameter ratio c.3.7; stipe absent; valve c.1.6 cm wide, margin straight, impressed and forming furrow, length to width ratio c.6.3. *Seeds* not known.

Distribution. Known from only two collections from Berau, East Kalimantan (see Fig. 9).

Habitat. Logged-over forest, limestone.

Altitude. Between 0 and 500 m.

Uses. None recorded.

IUCN conservation status Endangered B1ab(ii,iii,v)+B2ab(ii,iii). This species is known from only two localities, but the EOO is estimated to be less than 10 km^2. The AOO is 8 km^2. Habitat information for *Pterospermum glabrum* is based on just two records, the first from limestone and the second from logged forest. This habitat information may imply that this species is restricted to limestone, a rare substrate. The species may occur in logged forests either because it was not exploited or because it is able to grow in the high light regimen of a disturbed site. The latter trait appears to be common to many species of *Pterospermum* in Malesia. However, logged forest is very vulnerable to conversion to plantations across Borneo. Satellite images (Google Maps, no date) show that there has been substantial deforestation in the area where this species is found. Even though some individuals may be in protected areas, if this deforestation continues outside these areas, it is likely to result in a decline in the AOO and the extent and quality of habitat. This fulfils subcriteria b(ii) and (iii).

Etymology. Latin, *glabrum* = referring to the glabrous fruit surface.

Malesian specimens examined. INDONESIA. **East Kalimantan**: Berau, x 1997, *Ambriansyah* et al. 786 (BO, K, L); Labanan, x 1963, *Kostermans* 21528 (K, L).

12. Pterospermum grewiifolium Pierre, Fl. Forest. Cochinch. 2(12): t. 181 (1888); Gagnepain in Lecomte, Fl. Indo-Chine 1: 503 (1910). – Type: Vietnam, Tay Ninh, near Cai Công, iii 1866, *Pierre* 3778 (lecto P [P06594027], designated here; isolecto A [A00062912, A00348647], K [K000671876], MPU [MPU016409], NY [NY00222343]).

Pterospermum lanceifolium auct. non Roxb.: Kochummen in Whitmore, Tree Fl. Malaya 2: 367 (1973).

Tree to 15 m tall, 60 cm dbh, buttresses not present. *Outer bark* light brown to grey-brown, rough. *New twigs* covered in tawny hairs, becoming glabrous. *Stipules* caducous, divided into 2–8 parts, 8–12 mm long. *Leaves* alternate, internodes 0.5–2.5 cm long, petiole insertion marginal, petioles 4–6 mm long, 1.1–1.5 mm wide, covered in fawn hairs; blade unlobed, 8.3–13.7 cm long, 2.2–5 cm wide, length to width ratio 2.4–3.9, symmetrical, lanceolate, occasionally ovate to obovate, margin broadly toothed near apex, base asymmetrical, rounded on one side, acute or obtuse on the other, rarely subcordate, apex acute to acuminate; lamina coriaceous, discolorous, upper surface olive to occasionally sepia, glabrous, lower surface tawny, densely covered with fawn-coloured woolly hairs interspersed with larger chestnut-coloured stellate hairs; basal veins (excluding midrib) 2(–4), secondary veins (excluding basal veins) 5 or 6 (or 7) pairs, tertiary veins visible on lower surface, quaternary veins not visible on lower surface. *Inflorescence* of solitary axillary flowers; pedicels 30–50 mm long, 1–1.3 mm wide; epicalyx bracts 3, caducous, divided, c.11 mm long, not forming conspicuous clusters. *Flower* buds ovate, covered in chestnut-coloured hairs. *Sepals* 30–38 mm long, 2.9–3 mm wide, outer surface densely stellate hairy, fawn when dry, inner surface sericeous. *Petals* length not known. *Androgynophore* c.2.5 mm long, c.1.3 mm wide, anthers c.2.5 mm long, c.0.3 mm wide. *Ovary* ellipsoid, c.3.3 mm long, c.1.6 mm wide, tomentose, style hairy at base, clavate. *Fruit* pedicels 3.5–5.5 cm long, 2–3 mm wide, tawny, ovoid to cylindrical, terete, persistently tomentose, 5–8 cm long, 1.7–2.2 cm wide, length to diameter ratio 2.3–3.6; stipe absent; valve 1–1.5 cm wide, margin straight and plane, length to width ratio 5–5.3. *Seeds* glabrous, 25–30 mm long (including wing), 5–6 mm wide.

Distribution. Cambodia, Vietnam and Thailand. In Malesia, found in northern Peninsular Malaysia (Perlis, Perak, Kedah) (see Fig. 7).

Habitat. Mixed dipterocarp, secondary forests, and roadsides.

Altitude. From 0 to 500 m.

Uses. Wood used for construction and cabinet work, because it is said to take a fine polish (Gagnepain, 1910).

IUCN conservation status. Least Concern (LC). This species is widespread and is found in a wide range of habitats.

Etymology. Latin, *grewiifolium* = leaf like that of *Grewia*.

Additional Malesian specimens examined. MALAYSIA. **West Malaysia**: ***Kedah***: Langkawi, Kuah, 10 vi 1932, *Kerr* 21704 (K, L, SING [2]); Langkawi, Tanjung Rhu, 18 viii 1972, *Soepadmo & Mahmud* 1239 (K, KEP, L, SING); Langkawi, 7 Wells, 17 xi 1991, *Zainuddin* et al. AZ 4347 (K); Pulau Dayang Bunting, 17 v 1925, *Smith* 10101 (K, KEP, SING). ***Perak***: Temengor, 17 vii 1966, *Chelliah* 98629 (K, L, SING). ***Perlis***: Titi Tinggi, Mata Ayer FR, 15 vi 1966, *Kochummen* FRI 2016 (K, KEP, L, SING).

Wild-collected Malesian specimens previously identified as *Pterospermum lanceifolium* Roxb. are, in fact, *P. grewiifolium*. *Pterospermum lanceifolium* is not found in Malesia. Morphologically, the two species differ in that *Pterospermum grewiifolium* has divided stipules, a leaf lower surface with stellate hairs that have relatively longer branches (200–300 μM) giving a woolly appearance, an asymmetrical leaf base, an oblique shape, and caducous epicalyx bracts, whereas *P. lanceifolium* has entire stipules, a leaf lower surface with red stellate hairs with short branches (80–100 μM), a symmetrical leaf base that is rounded on both sides, and persistent epicalyx bracts. Within Malesia, *Pterospermum grewiifolium* is restricted to the northern part of West Malaysia. There are cultivated specimens of *Pterospermum lanceifolium* in Fort Canning, Singapore and the Penang Botanic Gardens.

Regarding nomenclature, the type locality is given as around Cai Công, Tay Ninh Vietnam. Cai Công cannot be located in the GEOnet Names Server (no date). There are location names similar to Cai Công near the city of Can Tho in Vietnam, and discussion with workers on the Vietnam flora suggests that the type locality may be near this area.

13. Pterospermum havilandii S.K.Ganesan, **sp. nov**.

Pterospermum havilandii is unique among *Pterospermum* species in Malesia by having sepal inner surfaces that are glabrous. It is similar to *Pterospermum aureum* S.K.Ganesan but differs in that its leaf upper surface dries darker than its leaf lower surface and its leaf shape is broadly lanceolate to falcate (in *P. aureum* the leaf upper surface dries lighter than the leaf lower surface and its leaf shape is elliptic). Other characters that differentiate *Pterospermum havilandii* and *P. aureum* are as follows: the leaf upper surface in *P. havilandii* is glabrous versus pubescent in *P. aureum*, and the leaf upper surfaces are of a different colour, with that in *P. havilandii* drying sepia versus fawn in *P. aureum*. – Type: Malaysia, Sarawak, Kuching District, Kom, 22 ix 1892, *Haviland* 1719 (holo L [L.3969980], iso K). **Fig. 18**.

Height not known, dbh not known, buttresses not known. *Outer bark* not known. *New twigs* covered in tawny hairs, becoming glabrous. *Stipules* caducous, heterophyllous, entire or bifid (entire stipules subulate, up 2.5 mm long, up to 1 mm wide, bifid stipules up to 9 mm long). *Leaves* alternate, internodes 1–2.2 cm long; petiole insertion marginal, petioles 4–7 mm long, 0.8–1.2 mm wide, covered in tawny to rarely whitish hairs; blade not lobed, 4.5–9 cm long, 2.2–3.5 cm wide, length to width ratio 2–3.6, slightly asymmetrical, broadly lanceolate to falcate, margin entire to repand, base asymmetrical, oblique, apex acuminate to caudate; lamina coriaceous, discolorous, upper surface sepia, glabrous,

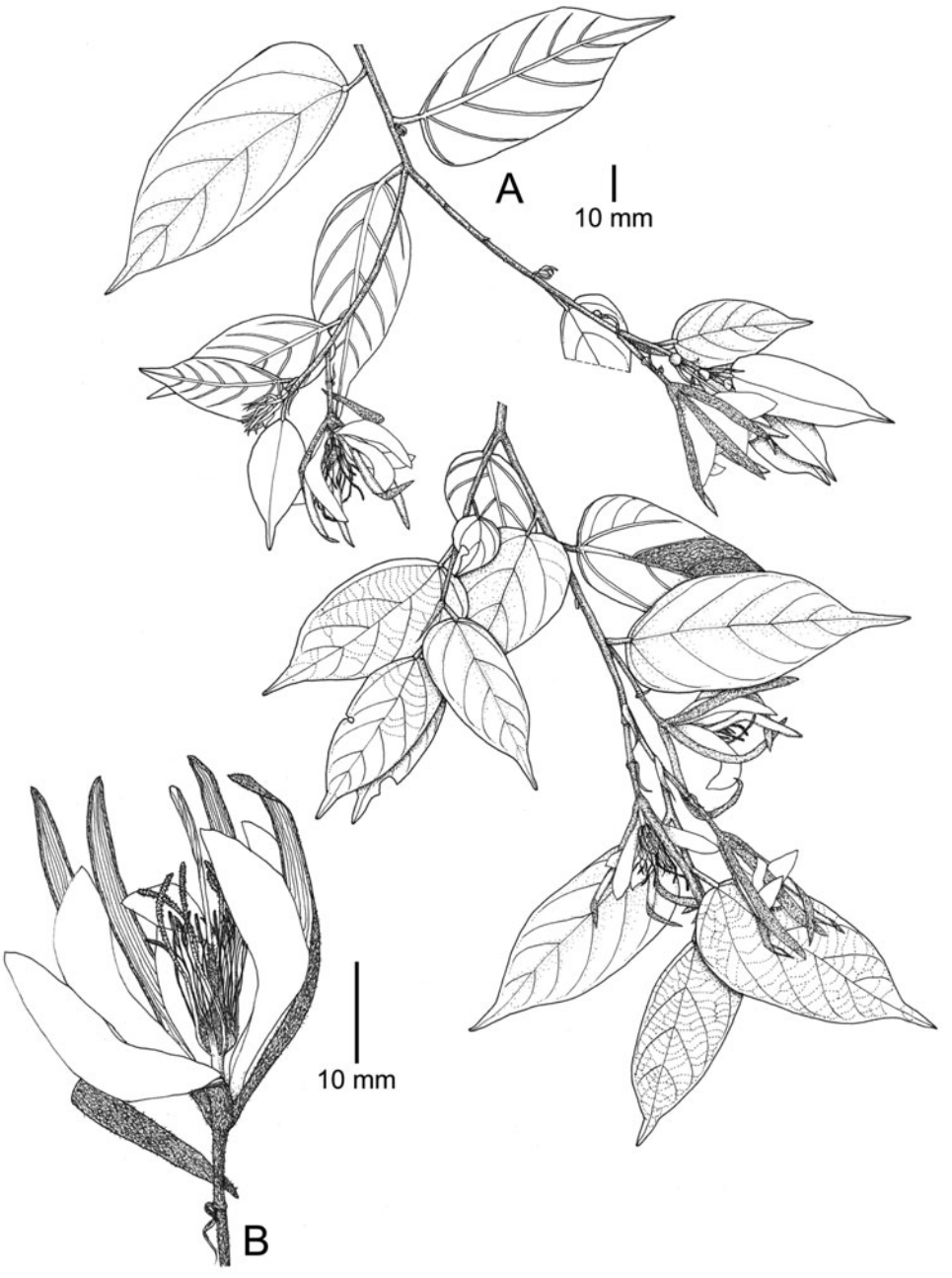

FIG. 18. *Pterospermum havilandii* S.K.Ganesan, sp. nov. (*Haviland* 1719 [K]). A, Twigs; B, flower. Drawing by Evonne Koh.

lower surface tawny, densely covered with tawny woolly simple hairs; basal veins (excluding midrib) 3, secondary veins (excluding basal veins) 4 pairs, tertiary veins not visible on lower surface, quaternary veins not visible on lower surface. *Inflorescence* of solitary axillary flowers, pedicels 20–21 mm long, 1.2–1.3 mm wide; epicalyx bracts caducous, 6–12 mm long, not forming conspicuous clusters. *Flower* buds not known. *Sepals* 41–44 cm long, 2.5–3 mm wide, outer surface densely stellate hairy, drying cinnamon, inner surface glabrous. *Petals* 27–30 mm long. *Androgynophore* c.7 mm long, c.1.2 mm wide, anthers 3.5–3.8 mm long, 0.2 mm wide. *Ovary* globose, c.5.2 mm long, c.4.8 mm wide, tomentose, style hairy at base, clavate. *Fruit* not known. *Seeds* not known.

Distribution. Known from only one collection from Sarawak, Borneo (see Fig. 15).

Habitat. Limestone vegetation.

Altitude. At about 500 m.

Uses. None recorded.

IUCN conservation status. Critically Endangered B1ab(iii)+B2ab(iii). Because there is only one record of this species, the EOO cannot be determined but is likely to be less than 10 km^2. The AOO is 4 km^2. It fulfils subcriterion a (based on number of locations). The species is associated with limestone substrate, and the collection location is not within a protected site. Limestone areas are susceptible to mining and fire. Recent satellite images show substantial amounts of deforestation in this area. This species is likely to have suffered a decline in the area, extent and quality of habitat, thus fulfilling subcriterion b(iii).

Etymology. Latin, *havilandii* = after Haviland, George Darby (1857–1901), collector of the type and one-time Director of the Raffles Museum, Singapore.

14. Pterospermum jackianum Wall. [Numer. List no. 1164 (1829), *nomen nudum*] ex Mast. in Hooker *f.*, Fl. Brit. Ind. 1: 367 (1875); King & Gamble, J. Asiat. Soc. Bengal, Pt 2, Nat. Hist. 60(3): 83 (1891); Kochummen in Whitmore, Tree Fl. Malaya 2: 367 (1973). – Type: Malaysia, Penang, Penang Gardens, *s.d.*, *Jack* in the Wallich Herbarium, Catalogue no. 1164 (lecto K-W [K001112268], designated here; isolecto G [G 00358517], K [K000671794]).

Small tree to 5 m tall, 5 cm dbh, buttresses not recorded. *Outer bark* grey brown, lenticellate. *New twigs* covered in fawn to tawny hairs becoming glabrous. *Stipules* caducous, entire, ensiform, 6–7.2 mm long, 1.2–1.4 mm wide. *Leaves* alternate or spiral, internodes 1.2–3.2 cm long; petiole insertion marginal, petioles 3.5–11.5 mm long (to 70 mm long in saplings), 1.1–1.5 mm wide, covered in tawny hairs; blade sometimes heterophyllous (lobed or not), 5.5–17 cm long, 2.7–5 cm wide, length to width ratio 1.8–3.5, symmetrical, rarely asymmetrical, oblong to obovate, occasionally elliptic (palmately lobed in orthotropic shoots), margin repand, base symmetrical to slightly asymmetrical, obtuse to truncate (peltate in orthotropic shoots), apex acuminate to

caudate; lamina coriaceous, discolorous, upper surface olive to sepia, glabrous, lower surface fawn, densely hairy, covered with fawn-coloured simple woolly hairs interspersed with larger stellate hairs; basal veins (excluding midrib) 2(–4), secondary veins (excluding basal veins) 9–11 pairs, tertiary veins visible on lower surface, quaternary veins visible on lower surface. *Inflorescence* of solitary axillary flowers; pedicels short, 3.5–5 mm long; epicalyx bracts 3, caducous, entire, subulate, 1.5–2.5 mm wide, not forming conspicuous clusters. *Flower* buds lanceolate, covered in chestnut-coloured hairs. *Sepals* 50–60 mm long, 2.3–3.9 mm wide, outer surface densely stellate hairy, drying fawn, inner surface sericeous. *Petals* 42–50 mm long. *Androgynophore* c.7 mm long, 1 mm wide, anthers c.9.7 mm long, c.2 mm wide. *Ovary* ovoid, c.4 mm long, c.2 mm in diameter, tomentose, style hairy throughout, clavate. *Fruit* not known. *Seeds* not known.

Distribution. Myanmar, Thailand. In Malesia, found in Peninsular Malaysia as far south as Malacca (see Fig. 7).

Habitat. Tree of dry open areas, on limestone or granite soils.

Altitude. Between 0 and 500 m.

Uses. None recorded.

IUCN conservation status. Least Concern (LC). Even though this species is not common in Malesia, it is common and widespread across the rest of its range.

Etymology. Latin, *jackianum* = after William Jack (1795–1822), Scottish botanist.

Additional Malesian specimens examined. MALAYSIA. **West Malaysia**: ***Kedah***: Bedong, Sg Petani, x 1925, *Meh* 8976 (K); Sg Pasir, x 1925, *Meh* FMS 9035 (E, KEP). ***Malacca***: 1866, *Maingay* 1853 (K). ***Penang***: Bukit Erskine, Apr. 1886, *Curtis* 783 (SING); Waterfall, vi 1890, *Curtis s.n.* (SING). ***Perak***: Kinta, Bukit Kinta F.R., 15 iii 2011, *Wilkie* et al. PW 891 (E, KEP).

Phengklai (2001) included *Pterospermum jackianum* as a synonym of *P. lanceifolium*. However, *Pterospermum jackianum* has pedicels that are shorter than the length of the sepals (subsessile) and *P. lanceifolium* has pedicels that are much longer than the sepals. Moreover, the juvenile leaves of *Pterospermum jackianum* are lobed, whereas those of *P. lanceifolium* are unlobed. The recognition of *Pterospermum jackianum* as a separate species is also supported by molecular evidence (Ganesan, 2016).

Pterospermum jackianum is sometimes confused with *P. grewiifolium*, but *P. grewiifolium* has a woolly appearance to the lower surface of its leaves, which *P. jackianum* does not, and the pedicels of *P. grewiifolium* are longer (30–50 mm long) than those of *P. jackianum* (3.5–5 mm long).

Regarding nomenclature, the name was first proposed by Wallich (1829), but without a description, and was validated by Masters (1875).

15. Pterospermum javanicum Jungh., Tijdschr. Natuurl. Gesch. Physiol. 7: 306 (1840). – Type: Indonesia, Java, West Java, 1835, *Junghuhn* 413 (lecto BO [BO1607168], designated here; isolecto L [L.3969953]).

Pterospermum javanicum Jungh. var. *montanum* Koord. & Valeton, Bijdr. Boomsoort. Java 2: 191 (1895). – Type: Indonesia, Java, Besuki, Pantjur-Idjen, 6 iv 1892, *Koorders* 10247 (lecto BO [BO1594567], designated here; isolecto L [L.3969736]).

Pterospermum subinaequale Miq., Fl. Ned. Ind., Eerste Bijv. 3: 404 (1861). – Type: Indonesia, West Sumatra, Priaman, *s.d.*, *Teijmann s.n.* (lecto BO [BO1594569], designated here; isolecto U [U1377082]).

Tree to 40 m tall, dbh not known, buttresses not recorded. *Outer bark* light brown to grey-brown, texture not known. *New twigs* not known. *Stipules* caducous, with gland, entire, filiform, 7–8 mm long, c.0.5 mm wide. *Leaves* alternate, internodes 1.3–2.1 cm long; petiole insertion marginal, petiole 9–10 mm long, 1.2–1.7 mm wide, covered in stramineous to chestnut-coloured hairs; blade not lobed, 6.3–11 cm long, 3–4.6 cm wide, length to width ratio 2–2.3, symmetrical to occasionally asymmetrical, ovate to elliptic, margin entire to repand, base asymmetrical, oblique, apex acuminate to occasionally cuspidate; lamina chartaceous, discolorous, upper surface tawny to sepia, glabrous, lower surface stramineous to chestnut-coloured, densely covered in fawn-coloured simple woolly hairs interspersed with fawn-coloured stellate hairs; basal veins (excluding midrib) 3 or 4, secondary veins (excluding basal veins) 5 or 6 pairs, tertiary veins visible on lower surface, quaternary veins faintly visible on lower surface. *Inflorescence* of solitary axillary flowers; pedicels 16–25 mm long, c.0.2 mm wide; epicalyx bracts fugaceous, not seen, not forming conspicuous clusters. *Flower* buds globose to cylindrical, covered in chestnut-coloured hairs. *Sepals* 5, 60–65 mm long, 6–7 mm wide, outer surface densely tomentose, drying tawny, inner surface woolly. *Petals* 51–56 mm long. *Androgynophore* c.4.2 mm long, c.1.5 mm wide, anthers 9.2–10 mm long, 0.5–0.6 mm wide. *Ovary* ellipsoid, c.9.2 mm long, c.4.7 mm in diameter, woolly, style hairy at base, clavate. *Fruit* pedicels c.3.5 cm long, c.3 mm wide, fruit chestnut-coloured, cylindrical, terete, persistently tomentose, 9–10.5 cm long, c.3.4 cm in diameter, length to width ratio c.2.6; stipe absent; valve 2–2.2 cm wide, margin straight and plane, length to valve width ratio c.5.3. *Seeds* glabrous, 40–46 mm long (including wing), 11–12 mm wide.

Distribution. Sumatra, Java and Lombok (Fig. 19). Reports that this species occurs in Bhutan, Myanmar and India need to be investigated.

Habitat. On the slopes of volcanic mountains.

Altitude. From 600 to 1500 m.

Uses. For construction.

IUCN conservation status. Least Concern (LC). This is species common and widespread.

Etymology. Latin, *javanicum* = from Java.

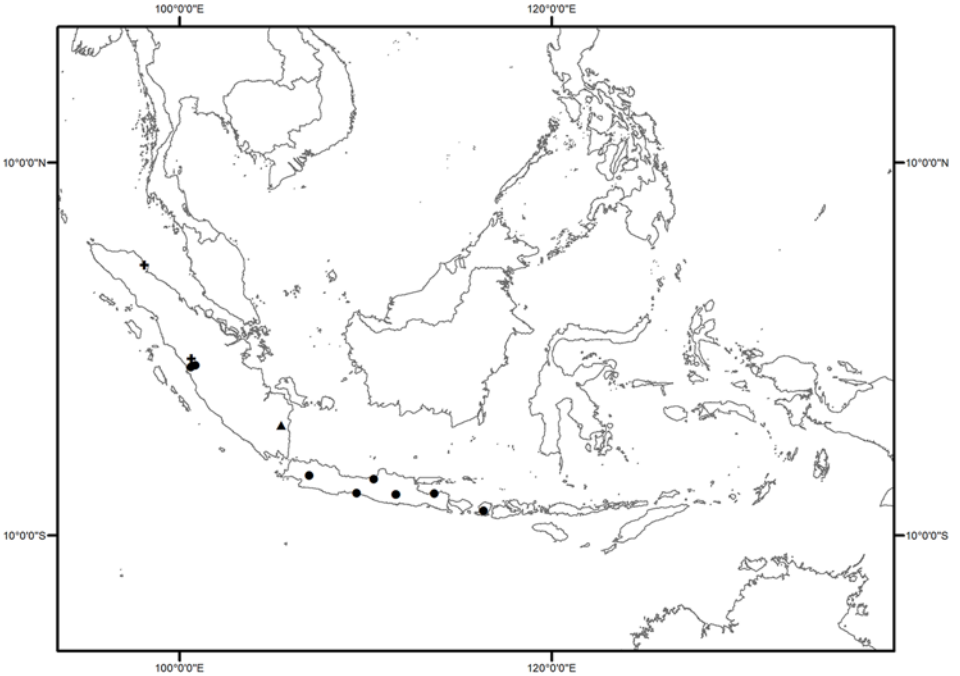

FIG. 19. Distribution of *Pterospermum javanicum* (•), *P. parvifolium* (▲) and *P. zollingerianum* (+) in Malesia.

Additional Malesian specimens examined. INDONESIA. **Java**: ***Central Java***: Semarang, 19 vi 1897, *Koorders* 27967β (SING); Telomojo, 16 v 1899, *Koorders* 36310 (L); Ngebel, 10 x 1892, *Koorders* 7797 (L); Tjoeramanis, 17 vii 1889, *Koorders* 7829 (L). ***West Java***: 1835, *Junghuhn*, 413 (BO, L); Gede, i 1924, *Uhl* 6623 (L). **Lombok**: 2 vii 2003, *Tokuoka* et al. T-0330 (BO). **Sumatra**: ***West Sumatra***: Padang Pandjang, 12 v 1924, *Boschproefstation* bb 6689 (L); Sago, 24 vi 1956, *Maradjo* 21 (L).

Regarding synonymy, we have found no distinction between *Pterospermum javanicum* var. *montanum* Koord. & Valeton and *P. javanicum* var. *javanicum*. The former varietal name is therefore placed in synonymy under the nominate variety.

Koorders & Valeton (1895) considered *Pterospermum blumeanum* to be a synonym of *P. javanicum*. However, these two species can be distinguished in that the fruit surface of the latter is persistently covered in a red-brown tomentum and the sepals are 60–65 mm long, 6–7 mm wide, whereas the fruit surface of the former is glabrescent and sepals are 29–39 mm long, 2.5–3.3 mm wide. The distinction between these two species is also supported by molecular evidence (Ganesan, 2016).

Regarding nomenclature, Junghuhn (1840) did not cite specimens or illustrate this species in his protologue. However, his protologue does contain a reference to the species being recorded on Mount Pangerango in West Java. We have found three specimens of *Pterospermum javanicum* in BO and L collected by Junghuhn from West Java. *Junghuhn* 413 (BO) matches the description and is the only specimen with flowers. This specimen is therefore here designated the lectotype.

16. Pterospermum longipes Merr., Philipp. J. Sci., C 7: 304 (1912); Merrill, Enum. Philipp. Fl. Pl. 50 (1923). – Type: Philippines, Camiguin, Mt Mahinog, 9 iv 1912, *Ramos* 14632 (holo PNH [destroyed]; lecto K [K000671866], designated here; isolecto US [US00102200]).

Tree to 10 m tall, dbh not known, buttresses not recorded. *Outer bark* colour and texture not known. *New twigs* covered in white hairs, becoming glabrous. *Stipules* fugaceous, not seen. *Leaves* alternate, internodes 0.7–2.2 cm long; petiole insertion marginal, petioles 5–7 mm long, 1–1.4 mm wide, covered in white hairs; blade not lobed, 5–11.7 cm long, 1.7–5 cm wide, length to width ratio 1.6–3, symmetrical, ovate to oblong, margin entire to repand, base asymmetrical, oblique to subcordate, when subcordate basal lobes 0.1–0.8 cm, apex acuminate to caudate; lamina chartaceous, discolorous, upper surface chestnut-coloured, glabrous, lower surface white to cream, densely covered with white to cream-coloured long woolly simple hairs; basal veins (excluding midrib) 5, secondary veins (excluding basal veins) 5 or 6 pairs, tertiary veins visible on lower surface, quaternary veins visible on lower surface. *Inflorescence* of 1 or 2 flowers in an axillary to pseudoterminal cyme; pedicels 40–60 mm long, 0.7–1 mm wide; epicalyx bracts 3, caducous, entire, filiform, c.6 mm long, c.0.5 mm wide. *Flower* buds ovate to oblong, covered in white to fawn hairs. *Sepals* 42–55 mm long, 3–5 mm wide, outer surface densely woolly to tomentose, fawn to tawny, inner surface woolly. *Petals* 37–47 mm long. *Androgynophore* c.10 mm long, c.0.8 mm wide, anthers c.8 mm long, c.0.3 mm wide. *Ovary* globose, c.4.2 mm long, c.4.3 mm in diameter, tomentose, style hairy at base, clavate. *Fruit* not seen, fusiform, terete, glabrous (fide Merrill, 1912), c.4 cm long (immature fruit). *Seeds* not known.

Distribution. Endemic to the Philippines, where it is found on Mindanao and Camuguin (see Fig. 15).

Habitat. In forests at low or medium altitude (Merrill, 1923).

Altitude. Not known.

Uses. None recorded.

IUCN conservation status. Endangered B2ab(ii,iii) (Ganesan, 2017g).

Etymology. Latin, *longipes* = long-footed, referring to the long flower pedicel.

Additional Malesian specimens examined. Philippines. **Mindanao**: Davao, Mati, iii 1927, *Ramos & Edaño* 49105 (NY); Surigao, 18 v 1927, *Wenzel* 2532 (NY).

We have not seen the fruits of this species, but the protologue records the immature fruit to be glabrous.

This species is exceptional, together with *Pterospermum glabrum*, among Malesian species in having fruits that are glabrous. *Pterospermum longipes* differs from *P. glabrum*

in that its leaf lower surface is white to cream-coloured and covered in woolly simple hairs, whereas in *P. glabrum* it is tawny and has minute stellate hairs.

Regarding nomenclature, all specimens at PNH were destroyed in 1941, during the Second World War (National Museum of the Philippines, no date). Because the holotype was destroyed, a lectotype is designated. From the syntypes, the specimen at K (K000671866) is selected as the lectotype because it shows the flowers, a key feature in the protologue, most clearly.

17. Pterospermum megalanthum Merr., Philipp. J. Sci. 14: 420 (1919); Merrill, Enum. Philipp. Fl. Pl. 50 (1923). – Type: Philippines, Panay, Capiz, Jamidan, 28 iv 1918, *Ramos & Edaño* 31269 (holo PNH [destroyed]; lecto A, designated here; isolecto K [K000671867], US [US0010220, US00416180]).

Tree to 8 m tall, dbh not known, buttresses not recorded. *Outer bark* not known. *New twigs* covered in tawny hairs, becoming glabrous. *Stipules* caducous, entire, lanceolate, 3.8–4.2 mm long, 1.7–1.8 mm wide. *Leaves* alternate, internodes 1.5–2.5 cm long; petiole insertion marginal, petiole 10–12 mm long, 1.8–2.1 mm wide, covered in tawny hairs; blade not lobed, 10.3–12.4 cm long, 5.3–5.5 cm wide, length to width ratio 1.9–2.3, ovate, asymmetrical, margin sinuate, base asymmetrical, oblique, basal lobes 1–1.3 cm, apex cuspidate; lamina coriaceous, discolorous, upper surface chestnut-coloured, glabrescent, lower surface tawny, densely hairy, covered with fawn-coloured simple woolly hairs interspersed with fawn-coloured stellate hairs; basal veins (excluding midrib) (4 or) 5, secondary veins (excluding basal veins) 5–7 pairs, tertiary veins faintly visible on lower surface, quaternary veins obscure on lower surface. *Inflorescence* of solitary axillary flowers; pedicels 30–40 mm long, 3.4–3.7 mm wide; epicalyx bracts fugaceous, not forming conspicuous clusters, entire, lanceolate. *Flower* buds ellipsoid, covered in tawny hairs. *Sepals* c.60 mm long, c.10 mm wide, outer surface densely stellate hairy, drying cinnamon in colour, inner surface sericeous. *Petals* 65 mm long. *Androgynophore* 15 mm long, 2 mm wide, anther length and width not known. *Ovary* ovoid, villous, style glabrous, clavate. *Fruit* not known. *Seeds* not known.

Distribution. Known from only two collections from the island of Panay, Philippines (see Fig. 15).

Habitat. Along streams in open forests, altitude about 100 m (from protologue).

Altitude. At about 100 m.

Uses. None recorded.

IUCN conservation status. Endangered B1ab(iii,v)+2ab(iii,v) (Ganesan, 2017h).

Etymology. Greek, *megalanthum* = large flower.

Malesian specimen examined. PHILIPPINES. **Panay**: Capiz, iv 1916, *Achacoso* 25359 (K, US).

This species is unique among *Pterospermum* in Malesia in that its petals are longer than the sepals. Because no flowers were available for examination, the description of the inflorescence and flowers is taken from the protologue.

Regarding nomenclature, a syntype from the Harvard University Herbaria (A) is designated lectotype because it shows the flower characters best. The extant type material lacks many of the flower characters, including the diagnostic long petals. It is likely that these features were present only on the destroyed specimen(s) formerly at PNH.

18. Pterospermum merrillianum S.K.Ganesan, **sp. nov**.

This species has been confused with *Pterospermum javanicum* Jungh. but differs by its longer flower pedicel (35–40 mm versus 16–25 mm long) and shorter petals (37–45 mm versus 51–56 mm long). In addition, the leaf apex of *Pterospermum merrillianum* is acuminate to caudate whereas that of *P. javanicum* is usually cuspidate to occasionally acute. *Pterospermum merrillianum* is also similar to *P. borneense* S.K.Ganesan but has wider leaves (3.8–5.2 cm versus 2.7–3 cm wide), wider sepals (2.8–5 mm versus 1.5–1.9 mm wide) and shorter fruit pedicels (c.3 cm versus 6–7 cm long) – Type: Philippines, Mindanao, Davao Province, Mati, iii–iv 1927, *Ramos & Edaño*, Bureau of Science No. 19106 (holo NY, iso BO). **Fig. 20**.

Tree to 23 m tall, 55 cm dbh, buttresses not recorded. *Outer bark* light brown to grey-brown, smooth to scaly. *New twigs* covered in fawn-coloured hairs, becoming glabrous. *Stipules* caducous, entire, filiform, 6–9 mm long, 0.4–2 mm wide. *Leaves* alternate, internodes 1.5–3.5 cm long; petiole insertion marginal, petioles 2–7 mm long, 1–2 mm wide, covered in fawn-coloured hairs; blade not lobed, 5.7–13 cm long, 3.8–5.2 cm wide, length to width ratio 1.4–2.9, symmetrical to occasionally asymmetrical, lanceolate to falcate, margin repand, base asymmetrical, oblique or occasionally subcordate, when subcordate basal lobes 0.4–1 cm, apex acuminate to caudate; lamina coriaceous, concolorous to discolourous, upper surface fawn to chestnut-coloured, glabrous, lower surface stramineous to fawn-coloured, densely covered with stramineous stellate hairs; basal veins (excluding midrib) 2 or 3, secondary veins (excluding basal veins) (4 or) 5 or 6 pairs, tertiary veins visible on lower surface, quaternary veins visible on lower surface. *Flower* buds oblong, covered in chestnut-coloured hairs. *Inflorescence* of solitary axillary flowers; pedicels c.40 mm long, c.1 mm wide; epicalyx bracts 3 (from scars on pedicel), caducous, morphology not known, not forming conspicuous clusters. *Sepals* 48–55 cm long, 2.8–3 mm wide, outer surface densely stellate hairy, drying cinnamon, inner surface strigose. *Petals* 37–45 mm long. *Androgynophore* c.8 mm long, c.0.6 mm wide, anthers c.4 mm long, c.0.4 mm wide. *Ovary* ellipsoid, c.6 mm long, c.4 mm wide, tomentose, style glabrous, clavate. *Fruit* pedicels c.3 cm long, c.3 mm wide, fruit tawny, fusiform, terete, indumentum persistent and tomentose, c.10 cm long, width not known (fruit dehisced), length to fruit width ratio not known; stipe absent; valve c.2 cm wide, margin straight and plane, length to width ratio c.5. *Seeds* glabrous, 40–42 mm long (including wing), 9–10 mm wide.

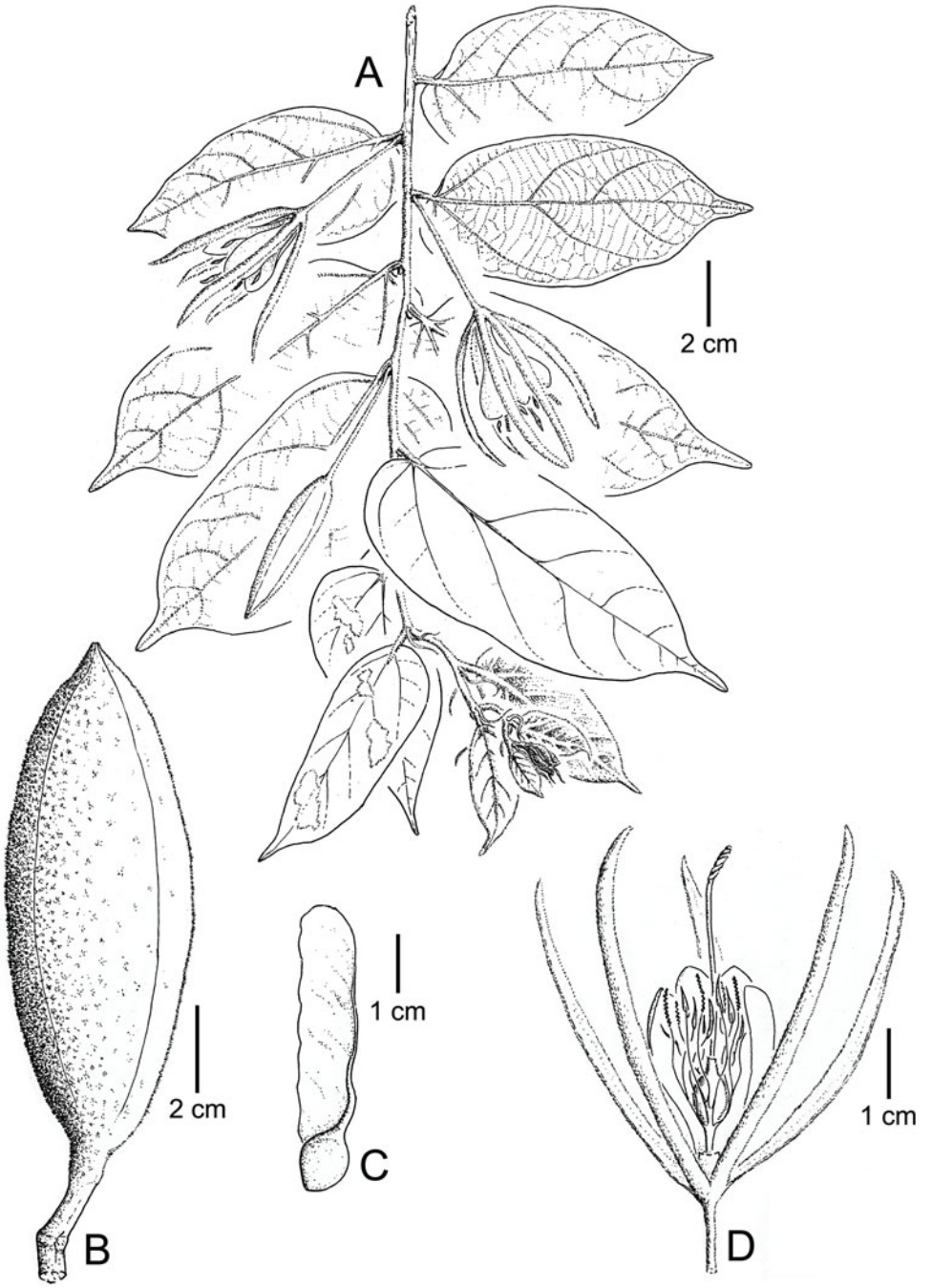

FIG. 20. *Pterospermum merrillianum* S.K.Ganesan, sp. nov. A, Twig (*Ramos & Edaño* 19106 [NY]); B, fruit (*Slik* MEPRI/ 5137 [L]); C, seed (*Slik* MEPRI/ 5137 [L]); D, flower (*Ramos & Edaño* 19106 [NY]). Drawing by Rebecca Camfield.

Distribution. Borneo (Sabah, East Kalimantan), Mindanao (see Fig. 15).

Habitat. Mixed dipterocarp forest and forests on ultramafic substrates.

Altitude. Between 0 and 500 m.

Uses. None recorded.

IUCN conservation status. Endangered B2ab(ii,iii). The EOO of this species is 83,836 km^2 and its AOO is 100 km^2. Recent satellite images show significant amounts of deforestation within the EOO, resulting in populations being isolated from another. It is likely that the majority of the population does not share genetic material with the main population. Therefore, it fulfils subcriterion a (severe fragmentation). There are no substantial protected areas within the EOO. The habitat of this species is mixed dipterocarp forest, which is threatened by deforestation and conversion to oil palm plantations. Continuing deforestation will result in a decline in AOO and area, extent and quality of habitat. This fulfils subcriteria b(ii) and (iii).

Etymology. Latin, *merrillianum* = after Merrill, Elmer Drew (1876–1956), American botanist, worker on the flora of the Philippines and Borneo.

Additional Malesian specimens examined. INDONESIA. **East Kalimantan**: Meratus, 15 i 2005, *Slik* MEPRI/ 5137 (L).

MALAYSIA. **East Malaysia**: ***Sabah***: Marudu, Kota Marudu, 22 vii 1948, *Austin* 1223 (SING); Lahad Datu, Danum, 1976, *Cockburn* SAN 85053 (L); Lahad Datu, Silam, 10 ix 1941, *Samosir* 1 (L); Lahad Datu, Silam, 21 vii 1961, *Chai Muin* SAN 26035 (SAN); Penampang, Lungamanis, 9 x 1967, *Staff* 61689 (SAN); Bettotan, 23 xi 1955, *Puasa* 4479 (L, SING); Langsikan, Sandakan Bay, 15 v 1967, *Meijer* 57697 (SAN); Seri Kedua, 9 vi 1979, *Termiji* SAN 90910 (SAN); Sg Sandakan, Mile 61 Telupid Rd, 5 vii 1980, *Termiji & Arshid* SAN 92571 (SAN); Semporna, Boheydulang Island, 11 x 1998, *Sugau* SIP B8 (SAN); Tuaran, Kampung Melangkap Tomis, Lakang (beside Sungei Penataran), 9 iv 1996, *Lugas* 1934 (SAN); Kampung Melangkap Tomis, Delungan (Temuan Sg Libang dan Sg Penataran), 10 v 1996, *Lugas* 2104 (K).

PHILIPPINES. **Mindanao**: Davao Province, Mati, iii 1927, *Ramos & Edaño*, Bureau of Science No. 19106 (BO, NY).

19. Pterospermum niveum S.Vidal, Revis. Pl. Vasc. Filip. 67 (1886); Merrill, Enum. Philipp. Fl. Pl. 50 (1923); Tang *et al*. in Wu *et al*., Fl. China 12: 327 (2007). – Type: Philippines, Luzon, Rizal Prov., San Mateo, *s.d*., *Vidal* 1185 (lecto MA [MA730077], designated here).

Tree to 12 m tall, 25 cm dbh, buttresses not recorded. *Outer bark* light grey to dark brown, smooth. *New twigs* covered in white to occasionally stramineous hairs, becoming glabrous. *Stipules* caducous, entire, subulate, 7–9 mm long, 0.8–1.2 mm wide. *Leaves* alternate, internodes 0.6–2 cm long; petiole insertion marginal, petioles 5–10 mm long, 1.5–1.6 mm wide, covered in white to occasionally stramineous hairs; blades not lobed, (7–)8.5–13 cm long, 3.5–6 cm wide, length to width ratio 2–3.1, asymmetrical to occasionally

symmetrical, elliptic, lanceolate to falcate, margin entire to repand, base asymmetrical, oblique to subcordate, when subcordate basal lobes 0.5–1.8 cm, apex acuminate to caudate; lamina chartaceous, discolorous, upper surface sepia, glabrous, lower surface white to cream, densely covered with white to cream, long, simple woolly hairs; basal veins (excluding midrib) 3–6, secondary veins (excluding basal veins) 6 or 7 pairs, tertiary veins visible on lower surface, quaternary veins visible on lower surface. *Inflorescence* of up to 3 flowers in an axillary cyme; pedicels 24–29 mm long, 1.2–1.8 mm wide; epicalyx bracts 3, caducous, entire, subulate, 1.7–2.5 mm long, 0.7–1.1 mm wide, not forming conspicuous clusters. *Flower* buds ovate, covered in white to occasionally stramineous hairs. *Sepals* 51–65 mm long, 5–6.5 mm wide, outer surface densely woolly, white to stramineous, inner surface woolly. *Petals* 42–50 mm long. *Androgynophore* 8–10 mm long, 0.8 mm wide, anthers 7.5–8 mm long, 0.5–0.6 mm wide. *Ovary* globose, 4–5.5 mm long, 4.5–3 mm in diameter, woolly, style hairy at base, clavate. *Fruit* pedicels c.4.5 cm long, c.3.5 mm wide, fruit sepia, fusiform, terete, glabrescent, 6–8.5 cm long, c.3 cm in diameter, length to diameter ratio c.2.3; stipe absent; valve c.1 cm wide, margin straight and plane, length to width ratio c.8.5. *Seeds* glabrous, 30–38 mm long (including wing), 6–7 mm wide.

Distribution. Taiwan and in Malesia, where it is restricted to the Philippines (Batanes, Luzon, Mindanao, Mindoro) (see Fig. 13).

Habitat. Mixed dipterocarp forest, riparian, and secondary forest.

Altitude. From 0 to 1500 m.

Uses. Not recorded.

IUCN conservation status. Least Concern (LC). This species is common and widespread in its overall distribution.

Etymology. Latin *niveum* = snow white, referring to the colour of the lower surface of the leaf.

Additional Malesian specimens examined. PHILIPPINES. **Batanes**: Batan, 28 iv 1996, *Madulid* et al. PPI 23911 (NY). **Camiguin Island**: Mt Mapollapola, Babuyanes, 18 v 1930, *Edaño* 79360 (NY). **Luzon**: ***Baatan Province***: Lamao River, Mt Mariveles, vi 1904 *Whitford* 1042 (A); Lamao River, Mt Mariveles, i 1905, *Borden* 2470 (NY). ***Benguet Province***: Baguio, iii 1907, *Elmer* 8514 (E). ***Bulacan Province***: Angat, *s.d.*, *Vidal* 1185 (NY). ***Cagayan Province***: Pinagsongayan River, ix 1929, *Edaño* 78557 (NY). ***La Union Province***: Buang, v 1916, *Fenix* 112 (A). ***Laguna Province***: Makiling National Park, ii 1933, *Sulit* 59 (NY); Montalban, x 1904, *Loher* 5566 (BO). ***Mountain Province***: Distr. Lepanto, *s.d.*, *Vidal* 1189 (NY). ***Nueva Ecija Province***: iii 1915, *Villavicencio* 23652 (A). ***Pangasinan Province***: Umingan, 4 x 1914, *Otanes* 18291 (A). ***Quezon Province***: Mt Cristobal, 17 xii 1996, *Reynoso* PPI 27305 (A). ***Rizal Province***: Antipolo, i 1914, *Ramos* 2081 (A); Bosoboso, xi 1904, *Ahern's collector* 250 (A, NY); x 1912, *Reillo* 19165 (A, SING). ***Tayabas Province***: i 1903, *Merrill* 2011 (A); Mt Binuang, iv 1917, *Ramos & Edaño* 28504 (A). ***Zambales Province***: Mt Aglao, San Mercelino, xii 1916, *Edaño* 26771 (A). **Mindanao**: ***Agusan Province***: 1950, *Anonueva* 13734 (A); Kitsaroa, Jabonga, iii 1949, *Mendoza & Convocar* 10410 (A); Cabadbaran, vii 1012, *Elmer* 13310 (A, NY). ***Surigao Province***: Lake Mainii, iii 1931, *Ramos & Convocar* 83378 (NY).

Zamboanga del Norte Province: ix 1958, *Frake* 38108 (A, K). **Mindoro**: Baco, i 1903, *Merrill* 1293 (A); Bongabon/Pimanalayan, v 1941, *Maliwanag* 139 (A); Paluan, iv 1921, *Ramos* 39500 (A); Sibuang R., San Teodoro, 12 ii 1985, *Ridsdale* 847 (A).

Pterospermum niveum is morphologically similar to *P. longipes*. However, the former has shorter pedicels (24–29 mm long) and glabrescent fruits, whereas the latter has pedicels 40–60 mm long and glabrous fruits. *Pterospermum niveum* is also very similar to *P. celebicum*, but its leaf lower surface is white and flower buds are ovate whereas *P. celebicum* has a fawn-coloured leaf lower surface and oblong flower buds.

Regarding nomenclature, in the protologue five gatherings are cited. According to Calabrese & Velayos (2009), Vidal's original herbarium was destroyed by fire, but a second set was deposited and is extant in the Real Jardín Botánico, Madrid (MA). Of these, *Vidal* 1185 (MA) is here chosen as the lectotype because it is the best specimen among the syntypes.

Merrill (1923) placed *Pterospermum formosanum* Matsum. in synonymy under *P. niveum*, but this name was applied only to specimens collected outside Malesia (Taiwan).

20. Pterospermum obliquum Blanco, Fl. Filip. 528 (1837); Merrill, Sp. Blancoan. 260 (1918), Enum. Philipp. Fl. Pl. 50 (1923). – Type: Philippines, Luzon, Rizal Province, vii 1912, *Andes s.n.* (Merrill: Species Blancoanae No. 286) (neo US [US0604329], designated here; isoneo A, K, NY).

Pterospermum semisagittatum auct. non Buch.-Ham. ex Roxb.: Blanco, Fl. Filip., ed. 2, 368 (1848).

Sczegleewia involucrata Turcz. (= *Pterospermum obliquum* Blanco), Bull. Soc. Nat. Moscou 31: 233 (1858) – *Pterospermum sczegleewia* (Turcz.) Turcz., Bull. Soc. Nat. Moscou 36: 573 (1863); Rolfe, J. Bot. 23: 211 (1885) – Type: Philippines, Luzon, 1841, *Cuming* 1022 (lecto NY [NY00222363], designated here; isolecto A, KW [KW001000112, KW0010001132], LECB [LECB0001607], M [M0211216], MW, OXF [2]).

Pterospermum blumeanum auct. non. Korth.: Merrill, Bull. Bur. Forest. Philipp. Islands 1: 37 (1903).

Tree to 20 m tall, 100 cm dbh, buttresses not recorded. *Outer bark* grey to brown, scaly. *New twigs* covered in tawny hairs, becoming glabrous. *Stipules* caducous, entire, lanceolate, c.9 mm long, c.1.9 mm wide. *Leaves* alternate, internodes 0.6–2 cm long; petiole insertion marginal, petioles 4–6 mm long, 1–1.6 mm wide, covered in fawn to tawny hairs; blade not lobed, 6–11 cm long, 1.7–4.1 cm wide, length to width ratio 2–4.5, asymmetrical, lanceolate to falcate, margin repand, base asymmetrical, oblique, apex acuminate, rarely caudate; lamina coriaceous, discolorous, upper surface tawny to chestnut-coloured, glabrous, lower surface fawn to tawny, densely covered with fawn-coloured, simple woolly hairs interspersed with fawn-coloured stellate hairs; basal veins (excluding midrib) 3 or 4, secondary veins (excluding basal veins) 5–7(–9) pairs, tertiary veins faintly visible on lower surface, quaternary veins obscure on lower surface. *Inflorescence* of 1 or 2 flowers in an axillary cyme; pedicels 6–11 mm long, c.1.5 mm wide; epicalyx bracts 7,

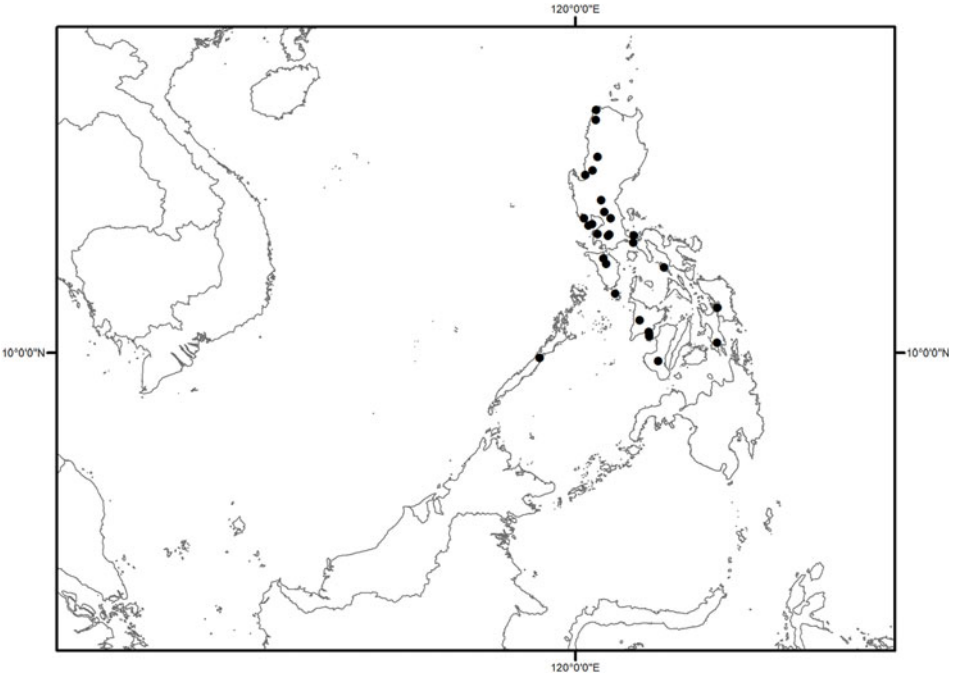

FIG. 21. Distribution of *Pterospermum obliquum* in Malesia.

persistent, entire, caudate, 6–10 mm long, 0.5–1.8 mm wide, forming conspicuous clusters. *Flower* buds ellipsoid, rarely ovoid, covered in chestnut-coloured hairs. *Sepals* 40–44 mm long, 1.5–2.5 mm wide, outer surface densely stellate hairy, drying cinnamon, inner surface woolly or stellate. *Petals* 29–45 mm long. *Androgynophore* 6–7 mm long, 0.8–1.1 mm wide, anthers 5.5–6 mm long, 0.4–0.6 mm wide. *Ovary* globose, 3.2–6.5 mm long, 3.2–3.5 mm in diameter, tomentose, style hairy at base, clavate. *Fruit* pedicels 3–3.5 cm long, 1–2 mm wide, fruit tawny, fusiform, terete, glabrescent, 4.2–7.3 cm long, c.2.5 cm wide, length to width ratio c.2.3; stipe absent; valve 0.9–1.2 cm wide, margin straight and plane, length to width ratio 3.5–4.7. *Seeds* glabrous, 22–42 mm long (including wing), 4–7 mm wide.

Distribution. Endemic to the Philippines, where it has been recorded from the following islands: Alabat, Guimaras, Leyte, Luzon, Marinduque, Mindoro, Negros, Palawan, Panay, Samar and Semirara (Fig. 21).

Habitat. Riparian and secondary forest.

Altitude. From 0 to 1000 m.

Uses. Not recorded.

IUCN conservation status. Least Concern (LC) (Ganesan, 2017i).

Etymology. Latin, *obliquum* = oblique, referring to the oblique-shaped leaf.

Additional Malesian specimens examined. PHILIPPINES. **Alabat Island**: ix 1926, *Ramos & Edaño* 48202 (NY, SING). **Burias Island**: vi 1904, *Clark* 1732 (NY). **Guimaras Island**: 1 i 1904, *Canmill* 245 (NY). **Luzon**: ***Bataan Province***: Lamao River, 1904, *Borden* 2370 (E); Morong, 12 ii 1991, *Soejarto* et al. 7543 (NY). ***Benguet Province***: Baguio, iii 1907, *Elmer* 8484 (A, E). ***Bulacan Province***: Angat, 18 xii 1994, *Garcia* et al. 15257 (A). ***Ilocos Norte Province***: Bangui, ii 1917, *Ramos* 27406 (A); Mt Pico de Loro, Mar. 1953, *Edaño* 17941 (A). ***Iloilo Province***: Nagpana, Barotac Viejo, 10 xi 1989, *Madulid* et al. 7195 (A). ***Laguna Province***: Calauan, *s.d*., *Vidal* 659 (A); Los Banos, iv 1906, *Elmer* 8150 (E); Mt Makiling, ii 1911, *Holman* 84 (A); Lepanto, i 1909, *Ramos* 7019 (BO). ***Rizal Province***: Montalban, *s.d*., *Vidal* 99 (A). **Marinduque Island**: Dampulan, 30 x 1996, *Romero & Chavez* PPI 29151 (A). **Mindoro**: Mt Yagaw, v 1953, *Sulit & Conklin* 7741 (A); San Teodoro, 17 ii 1985, *Risdale* 888 (A). **Negros**: v 1908, *Elmer* 9982 (A, NY). **Palawan**: x 1905, *Bermejos* 253 (A). **Panay**: Mt Balo, Musay, 5 vii 1987, *Varadarajan* et al. *s.n*. (A, NY). **Samar**: x 1915, *Phasis* 24641 (A). **Semirara**: Caluya, 2 ii 1997, *Romero & Majaducon* 29500 (A).

Pterospermum obliquum and *P. elmeri* frequently bear conspicuous clusters of epicalyx bracts, which are not found in other Malesian species, but *P. obliquum* has lanceolate to falcate leaves whereas *P. elmeri* has ovate leaves.

Regarding nomenclature, it is widely accepted that Blanco did not preserve his specimens (Merrill, 1918), and we have not found any *Pterospermum* specimens collected by him. We have followed the established approach (e.g. Veldkamp, 1989; Nicolson & Arculus, 2001) of neotypifiying Blanco's species by designating the relevant material in Merrill's *Species Blancoanae* in US as the neotype of *P. obliquum*.

Blanco's description of *Pterospermum obliquum* (Fl. Filip. 528 [1837]) is identical to his later description of *P. semisagittatum* (Fl. Filip., ed. 2, 368 [1848]). This corroborates Merrill's (1918) argument that these species are conspecific. *Pterospermum semisagittatum* Buch.-Ham. ex Roxb., in its original sense, has a semisagittate leaf base (Roxburgh, 1832), whereas no Philippine species has been found to have this character. Therefore, *Pterospermum semisagittatum* is not found in the Philippines and Blanco misapplied this name to *P. obliquum*.

Two gatherings of *Sczegleewia involucrata* are cited in the protologue, *Cuming* 1022 and *Cuming* 1223. Of these, *Cuming* 1022 (NY) is here designated as the lectotype.

21. Pterospermum parvifolium Miq., Fl. Ned. Ind., Eerste Bijv. 3: 403 (1861). – Type: Indonesia, Sumatra, Sumatra Barat, Priaman, *Diepenhorst s.n*. Neotype: Indonesia, Sumatra, Palembang, Lematang, 19 xi 1923, *Boschproefstation* no. T. 930 (neo L [L.3969586], designated here).

Tree height not known, dbh not known, buttresses not recorded. *Outer bark* not known. *New twigs* covered in fuscous hairs, becoming glabrous. *Stipules* caducous, morphology not known. *Leaves* alternate, internodes 1–1.5 cm long; petiole insertion marginal, petiole 2–4 mm long, covered in fuscous hairs; blade not lobed, 5.2–8.5 cm long, 2.5–4 cm wide, length to width ratio 2.1–2.2, symmetrical to slightly asymmetrical, elliptic to oblong, occasionally falcate, margin repand, base asymmetrical, oblique, apex acuminate; lamina coriaceous, concolorous to occasionally discolorous, upper surface tawny, largely

glabrescent with persistent hairs on the midrib, lower surface tawny, densely covered with a layer of tawny stellate hairs over a layer of woolly tawny simple hairs; basal veins (excluding midrib) 2 or 3, secondary veins (excluding basal veins) 4 or 5 pairs, tertiary veins visible on lower surface, quaternary veins visible on lower surface. *Inflorescence* of 1 or 2 flowers in a terminal cyme; pedicels 10–15 mm long, c.2 mm wide; epicalyx bracts 3, caducous, entire, subulate, 5.3–5.8 mm long, 1.3–1.7 mm wide, not forming conspicuous clusters. *Flower* buds cylindrical, covered in chestnut-coloured hairs. *Sepals* 50–55 mm long, 4–5 mm wide, outer surface densely stellate hairy, drying fuscous, inner surface sericeous, lamina not visible. *Petals* 35–40 mm long. *Androgynophore* 7–8.4 mm long, c.1.2 mm wide, anther length not known, c.0.3 mm wide. *Ovary* ellipsoid, 5.8–6.2 mm long, 3.7–4.2 mm in diameter, tomentose, style glabrous, clavate. *Fruit* not known. *Seeds* not known.

Distribution. Known from two collections from the same locality in Sumatra (see Fig. 19).

Habitat. Not known.

Altitude. Not known.

Uses. None recorded.

IUCN conservation status. Critically Endangered (Possibly Extinct) B1ab(iii)+2ab(iii) (Ganesan, 2017j).

Etymology. Latin, *parvifolium* = small-leaved.

Additional Malesian specimen examined. INDONESIA. **Sumatra**: Palembang, Lematang, xi 1923, Boschproefstation T 524 (L).

This species was described by Miquel in 1861 and later (Miquel, 1870) placed in synonymy under *Pterospermum javanicum*. *Pterospermum parvifolium*, however, is a distinct species in that it has shorter (50–55 mm long) and narrower (4–5 mm wide) sepals and coriaceous leaves, whereas *P. javanicum* has longer (60–65 mm long) and wider (6–7 mm wide sepals) and chartaceous leaves.

Regarding nomenclature, *Pterospermum parvifolium* was based on a collection made by H. Diepenhorst. According to van Steenis-Kruseman (1950), Diepenhorst's collections are located at BO and L. We have searched these collections and were not able to find any original material, all of which is therefore presumed lost or destroyed. Following Article 9.16 of the *ICN*, a neotype is designated. The specimen Boschproefstation no. T. 930 (L [L.3969586]) is in the best condition among the specimens of *Pterospermum parvifolium* and hence is selected as the neotype.

22. Pterospermum pecteniforme Kosterm., Reinwardtia 6: 296 (1962); Kochummen in Whitmore, Tree Fl. Malaya 2: 367 (1973); Phengklai in Santisuk & Larsen, Fl. Thailand 7: 599 (2001). – Type: Thailand, Ko Samui, 24 v 1927, *Put* 674 (lecto K [K001092796], designated here; isolecto K [K001092795]).

Tree to 25 m tall, 60 cm dbh, buttresses not recorded. *Outer bark* light brown, dippled. *New twigs* covered in fimbriate scales, becoming glabrous. *Stipules* caducous, entire, lanceolate, c.2.9 mm long, c.0.5 mm wide. *Leaves* alternate, internodes 0.6–3.5 cm long (up to 8.5 cm long in orthotropic shoots); petiole insertion marginal (subpeltate in orthotropic shoots), petioles 6–11 mm long (up to 115 mm in orthotropic shoots), 0.9–1.6 cm wide, covered in fimbriate scales; blades not lobed, 4.6–10.4 cm long (up to 28 cm long in orthotropic shoots), 2.8–6.5 cm wide, length to width ratio 1.6–2.3, symmetrical, elliptic, oblong to obovate-oblong (palmately lobed in orthotropic shoots), margin repand, base symmetrical, obtuse, apex acute; lamina chartaceous, discolorous, upper surface cinnamon to occasionally sepia, glabrous, lower surface stramineous to occasionally fawn-coloured, densely covered with silvery fimbriate scales; basal veins (excluding midrib) 3 or 4, secondary veins (excluding basal veins) 7–10 pairs, tertiary veins very visible on lower surface, quaternary veins obscure on lower surface. *Inflorescence* of solitary axillary flowers; pedicels c.9 mm long, c.4 mm wide; epicalyx bracts fugaceous, number and morphology not known, not forming conspicuous clusters. *Flower* buds lanceolate, covered in chestnut-coloured hairs. *Sepals* 30–32 mm long 3.2–3.5 mm wide, outer surface densely stellate hairy, drying cinnamon, inner surface sericeous. *Petals* 27–29 mm long. *Androgynophore* 11–12 mm long, 0.8–1.1 mm wide, anthers 5–6.6 mm long, c.0.3 mm wide. *Ovary* ellipsoid to ovoid, 4.2–5 cm long, 1.5–1.8 mm in diameter, covered in fimbriate scales, style hairy at base, clavate. *Fruit* pedicels 1.4–1.5 cm long, 2.5–2.6 mm wide, fruit tawny to sepia, fusiform, angular, minutely scaly, 6.3–8 cm long, 3–3.3 cm in diameter, length to width ratio 2.4–3.1; stipe present, 6–9 mm long, 6–7 mm in diameter, length to width ratio 1–1.29; valve 2–2.2 cm, margin wavy, raised and forming a flange, length to width ratio 2.9–3.1. *Seeds* c.39 mm long (including wing), c.8 mm wide.

Distribution. Thailand and Malesia, where it is recorded from northern Peninsular Malaysia in the states of Perlis and Kedah (see Fig. 7).

Habitat. Limestone forests.

Altitude. From 0 to 250 m.

Uses. None recorded.

IUCN conservation status. Data Deficient, because this species is also found outside Malesia and there is a lack of information on these populations. This species is restricted to limestone habitats, which are threatened by mining, fire and deforestation. It is not common in Malesia.

Etymology. Latin, *pecteniforme* = comb-shaped, referring to the shape of the valve margin in the fruit.

Additional Malesian specimens examined. MALAYSIA. **West Malaysia**: ***Kedah***: Alor Star, G. Keriang, 20 iv 1938, *Kiah* 35425 (K, L); Kodiang, 21 v 1957, *Chew* 196 (K, L, SING). ***Perlis***: Buah Kerbau, 7 v 1968, *Ogata* 10292 (KEP, L).

This is the only *Pterospermum* species in Malesia that has a leaf lower surface covered with silvery fimbriate scales. It is similar to *Pterospermum diversifolium* but (in addition to scales) also differs in that the valve margin of its fruits is wavy rather than straight.

Regarding nomenclature, there are two duplicates of the type specimen, *Put* 674, at Kew. Because the protologue did not designate one as the holotype, a lectotypification is necessary. K001092795 comprises a leafy twig and a seed. K001092796 comprises fruits and seeds. K001092796 is selected here as the lectotype because it is more informative in reproductive characters.

23. Pterospermum stapfianum Ridl., Bull. Misc. Inform. Kew 10: 489 (1933). – Type: Malaysia, Sarawak, Belaga, Rejang, xi 1893, *Haviland* 2125 (lecto K [K000671872], designated here; isolecto L [L.0062821]).

Pterospermum subpeltatum auct. non Merr.: Ashton, Man. Non-Dipterocarp. Trees Sarawak 402 (1988); Wilkie & Berhaman in Soepadmo *et al*., Tree Fl. Sabah Sarawak 7: 368 (2011).

Tree to 40 m tall, 53 cm dbh, buttresses occasionally present. *Outer bark* pale-grey to grey-brown, smooth or lenticellate. *New twigs* covered in tawny hairs, becoming glabrous. *Stipules* caducous, entire, subulate, 3–4 mm long, 0.9–2.5 mm wide. *Leaves* alternate or spiral, internodes 1–3 cm long; petiole insertion subpeltate, petioles 4–12 mm long, 0.9–1.8 mm wide, covered in tawny hairs; blades not lobed, (6.5–)7–14.5(–16) cm long, 3.2–7(–9.5) cm wide, length to width ratio 2.1–2.2, symmetrical, oblong to obovate, rarely ovate, margin repand, base symmetrical to slightly asymmetrical, rounded to occasionally truncate, depth of base 0.4–0.8 cm (from point of insertion to base of leaf), apex cuspidate to acuminate; lamina chartaceous, discolorous, upper surface sepia, occasionally chestnut-coloured, glabrescent, lower surface fawn to tawny-coloured, densely covered in fawn-coloured woolly simple hairs; basal veins (excluding midrib) 4–6, secondary veins (excluding basal veins) (4 or) 5–7 pairs, tertiary veins very visible on lower surface, quaternary veins obscure on lower surface. *Inflorescence* of 1 or 2 flowers in an axillary cyme; pedicels 20–40 mm long, 1–1.2 mm wide; epicalyx bracts 3, caducous to rarely persistent, entire, subulate, 4–5 mm long, 1–1.6 mm wide, not forming conspicuous clusters. *Flower* buds oblong, covered in tawny hairs. *Sepals* 45–65 mm long, 3.6–4.8 mm wide, outer surface densely stellate hairy, yellow when fresh, drying tawny, inner surface strigose. *Petals* 40–42 mm long. *Androgynophore* 10–12 mm long, 0.8–1.4 mm wide, anthers 7–10 mm long, 0.3–0.4 mm wide. *Ovary* ellipsoid to ovoid, 3.4–4.8 mm long, 2.5–4.4 mm wide, tomentose, style hairy at base, clavate. *Fruit* pedicels 4–5.5 cm long, 2–3 mm wide, chestnut-coloured to sepia, fusiform to cylindrical, terete, glabrescent, 7–9 cm long, 2.5–2.6 cm in diameter, length to width ratio 2.7–2.8; stipe absent; valve straight and plane, valve 1.5–2 cm wide, margin straight and plane, length to width ratio 4.3–5.7. *Seeds* glabrous, 35–50 mm long (including wing), 11–12 mm wide.

Distribution. Endemic to Borneo, where it is recorded from Sabah and Sarawak (Fig. 22).

Habitat. Alluvial, secondary, riparian and mixed dipterocarp forests.

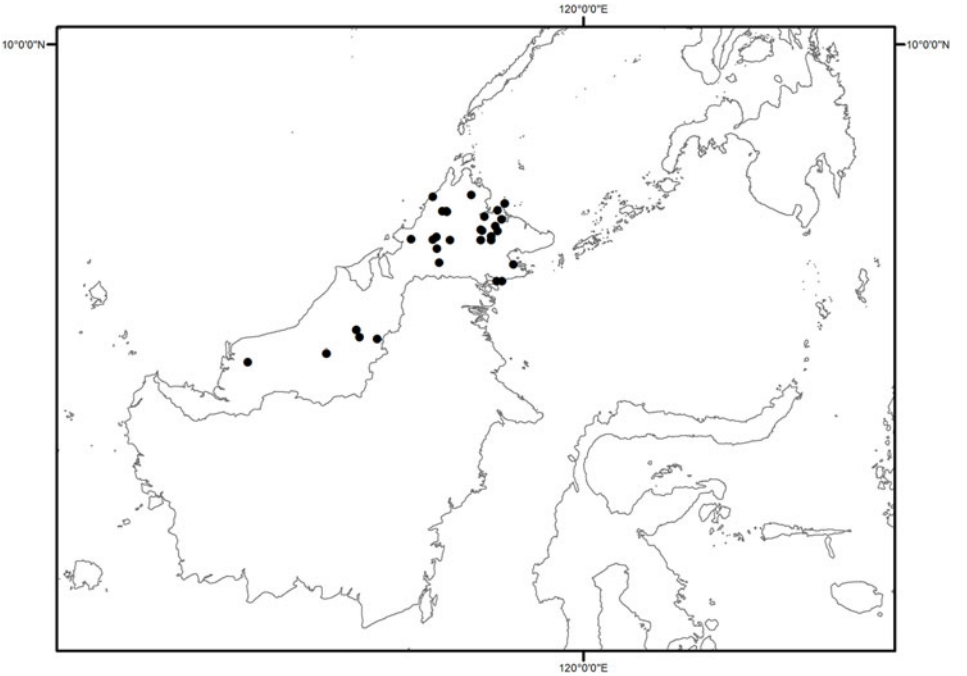

FIG. 22. Distribution of *Pterospermum stapfianum* in Malesia.

Altitude. From 0 to 1000 m.

Uses. Timber used for construction.

IUCN conservation status. Least Concern (Ganesan, 2017k).

Etymology. Latin, *stapfianum* = after Stapf, Otto (1857–1933), Austrian-born Austrian and British botanist.

Additional Malesian specimens examined. MALAYSIA. **East Malaysia**: ***Sabah***: Beaufort, Halogilat, 2 xi 1962, *Mikil* SAN 31821 (KEP, L); Keningau, Sepulut Forest Reserve, 18 x 1983, *Sigin Gambukas* et al., SAN 69070 (L, SAN); Kinabatangan, Lamag, 29 v 1963, *Ampuria* 35338 (KEP, SAN, SING); Kinabatangan, Bolunan Hill, 3 vi 1963, *Jawanting* 36528 (SAN); Kinabatangan, Lamag, Malua Camp, 15 v 1967, *Osman Mungkim* 45116 (KEP, SAN, SING); Ranau, Peranchangan, 1 vi 1973, *Shea & Aban* 77332 (L, SING); Sandakan, Lokan F.R., 2 vi 1963, *Banang* 36947 (SAN, SING); Sandakan, Lungmanis, 22 x 1955, *Wood & Kusebio* SAN 17206 (KEP, L, SING); Tenom, Pangi, 23 iv 1969, *Aban & Nicholas* SAN 65271 (SAN); Tawau, 16 ix 1963, *Sinanggul* 40514 (SAN); Tawau, Tawau Hill Park, 22 iii 1992, *Berhaman* 134537 (KEP, SING). ***Sarawak***: Belaga, 15 v 1963, *Ashton* S 18272 (KEP, L, SAN, SAR, SING); Marudi, Dapoi, 28 ii 1965, *Murthy* S 23340 (KEP, L [2], SAR, SING); Marudi, 28 iii 2003, *Julia & Soepadmo* et al. S 91980 (KEP, SAR, SING).

This species has been confused with *Pterospermum subpeltatum* (e.g. Ashton, 1988; Wilkie & Berhaman, 2011). *Pterospermum stapfianum* is distinct from *P. subpeltatum* in

that its sepals are longer (40–42 mm) and wider (3.6–5.8 mm), its leaf apex is cuspidate, and its fruit indumentum is glabrescent. In *Pterospermum subpeltatum* the sepals are 28 mm long, 12–14 mm wide, the leaf apex is acuminate, and the fruit indumentum is persistently hairy.

Glands at the base of stipules have been observed in living material of *Pterospermum stapfianum*.

Regarding nomenclature, the specimen at K (K0067172), annotated by Ridley himself, is chosen as the lectotype.

24. Pterospermum subpeltatum Merr. in C.B. Rob., Philipp. J. Sci., C 3: 204 (1908); Merrill, Enum. Philipp. Fl. Pl. 3: 49 (1923). – Type: Philippines, Mindanao, Zamboanga, Sax River, 18 ii 1905, *Williams* 2350 (lecto NY [NY00222354], designated here; isolecto NY [NY00222353]).

Tree to 17 m tall, 35 cm dbh, buttresses not recorded. *Outer bark* dark grey, scaly. *New twigs* covered in fawn hairs, becoming glabrous. *Stipules* caducous, entire, filiform, 7–12 mm long, c.1 mm wide. *Leaves* alternate, internodes 3–4.5 cm long; petiole insertion marginal to subpeltate, petiole 5–6 mm long, 2 mm wide, covered in fawn-coloured hairs; blade not lobed, 14.7–18.5 cm long, 6.5–7.4 cm wide, length to width ratio 2.3–2.5, symmetrical to asymmetrical, lanceolate, margin repand, base asymmetrical, oblique, depth of base 0.1–0.2 cm (from point of insertion to base of leaf), apex acuminate; lamina coriaceous, discolorous, upper surface chestnut-coloured, glabrescent, lower surface tawny, densely covered with fawn-coloured simple woolly hairs interspersed with fawn-coloured stellate hairs; basal veins (excluding midrib) 2, secondary veins (excluding basal veins) 5 or 6 pairs, tertiary veins very visible on lower surface, quaternary veins obscure on lower surface. *Inflorescence* of axillary solitary flowers; pedicels 15–20 mm long, c.1.3 mm wide; epicalyx bracts 3, caducous, divided, bifid, c.10 mm long, not forming conspicuous clusters. *Flower* buds not known. *Sepals* c.35 mm long, 1.2–1.4 mm wide, outer surface densely stellate hairy, drying cinnamon, inner surface strigose. *Petals* c.28 mm long. *Androgynophore* c.6 mm long, 0.8–1 mm wide, anthers c.5 mm long, c.0.3 mm wide. *Ovary* globose, c.6.5 mm long, c.5.4 mm in diameter, tomentose, style hairy at base, clavate. *Fruit* pedicels c.3 cm long, c.2 mm wide, fruit tawny, fusiform to falcate, terete, persistently tomentose, 5–7 cm long, diameter not known (fruits available are dehisced), length to width ratio not known; stipe absent; valve c.1 cm wide, margin straight and plane, length to width ratio 5–7. *Seeds* glabrous, c.20 mm long (including wing), c.8 mm wide.

Distribution. Known from two specimens collected in Mindanao (see Fig. 15).

Habitat. On forested slopes.

Altitude. From 0 to 500 m.

Uses. None recorded.

IUCN conservation status. Endangered B2ab(ii,iii) (Ganesan, 2017l).

Etymology. Latin, *subpeltatum* = subpeltate, referring to the position of insertion of the petiole into the leaf blade.

Additional Malesian specimen examined. PHILIPPINES. **Mindanao**: Zamboanga, Lake Lanao, Camp Keithley, v 1906, *Clemens* 522 (K).

Pterospermum subpeltatum is sometimes confused with *P. stapfianum*. However, in *Pterospermum subpeltatum* the depth of petiole insertion is 0.1–0.2 cm, the sepals are shorter (28 mm long) and narrower (1.2–1.4 mm wide), and the fruit indumentum is persistently hairy. In *Pterospermum stapfianum* the depth of petiole insertion is 0.4–0.8 cm, the sepals are longer (40–42 mm) and wider (3.6–5.8 mm), and the fruit is glabrescent.

Regarding nomenclature, according to van Steenis-Kruseman (1950), Williams' specimens were deposited at NY, which has two syntypes of this name. One (NY00222354) shows both the leaf upper surface and leaf lower surface, whereas the other (NY00222253) shows only the leaf upper surface. Accordingly, the former (NY00222354) is selected as the lectotype.

25. Pterospermum sumatranum Miq., Ill. Fl. Archip. Ind. 2: 87 (1870). – Type: Indonesia, Sumatra, Indrapoera, *s.d.*, *Korthals* T 964a (lecto L [L.3969949], designated here; isolecto L [L.3969950]), NY [NY00222356]).

Pterospermum blumeanum auct. non Korth.: King & Gamble, J. Asiat. Soc. Bengal, Pt 2, Nat. Hist. 60(3): 83 (1891); Ridley, Fl. Malay Penins. 1: 282 (1922).

Pterospermum javanicum auct. non Jungh.: Kochummen in Whitmore, Tree Fl. Malaya 2: 367 (1973); Corner, Wayside trees Mal.: 709 (1988).

Tree to 30 m tall, 55 cm dbh, buttresses present. *Outer bark* grey, rough. *New twigs* covered in tawny to chestnut-coloured hairs, becoming glabrous. *Stipules* fugaceous, morphology not known. *Leaves* alternate, internodes 0.6–3.4 cm long; petiole insertion marginal, petioles 2–6 mm long, 1–2 mm wide, covered in stramineous to tawny hairs; blade not lobed, 3.4–14.5 cm long, 2–6.5 cm wide, length to width ratio 1.7–2.3, asymmetrical, ovate, oblong to falcate, margin repand, base asymmetrical, oblique to subcordate, when subcordate basal lobes 2–10 mm, apex acuminate; lamina coriaceous, discolorous, upper surface chestnut-coloured to sepia, glabrescent, lower surface stramineous to tawny, occasionally whitish, densely covered in fawn-coloured stellate hairs; basal veins (excluding midrib) 4–6, secondary veins (excluding basal veins) 5–8 pairs, tertiary veins faintly visible to not visible on lower surface, quaternary veins faintly visible to not visible on lower surface. *Inflorescence* of up to 3 axillary and/or terminal flowers in a cyme; pedicels 17–26 mm long, 0.8–1.4 mm wide; epicalyx bracts 3, caducous, not dissected, subulate, 2.5–5.8 mm long, 0.8–1 mm wide, not forming conspicuous clusters. *Flower* buds ellipsoid to obovate, covered in tawny hairs. *Sepals* 50–60 mm long, 2–5 mm wide, outer surface densely tomentose, drying tawny, inner surface woolly, obscuring leaf lamina. *Petals* 30–40.5 mm long. *Androgynophore* 7–9 mm long, 0.7–1 mm wide, anthers 5–8.3 mm

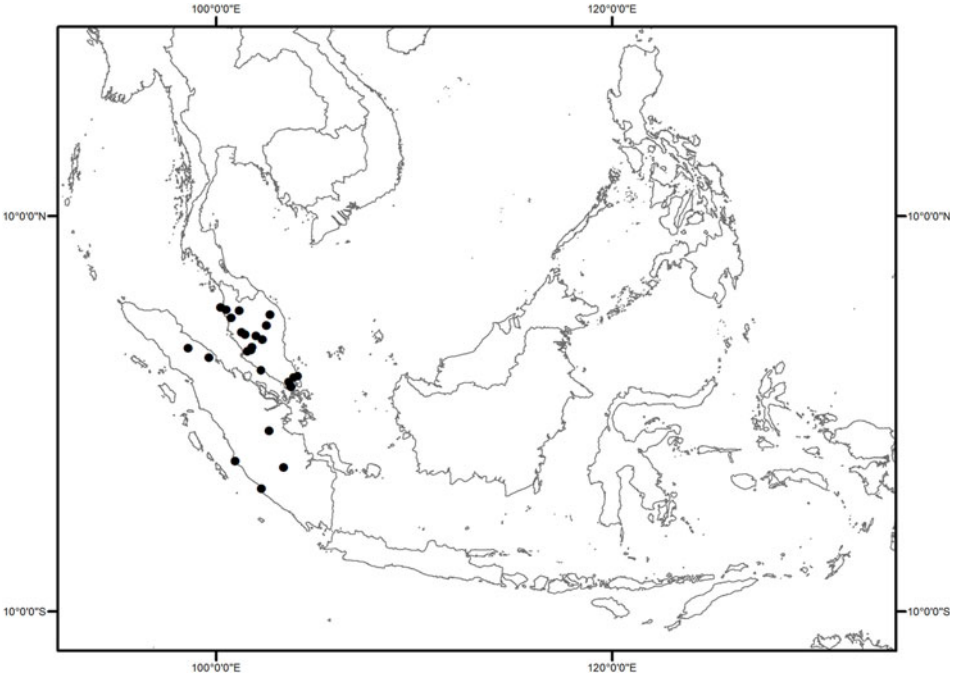

FIG. 23. Distribution of *Pterospermum sumatranum* in Malesia.

long, c.0.3 mm wide. *Ovary* ovoid, 3.8–7.1 mm long, 3–5.5 mm in diameter, tomentose, style hairy in lower half, clavate. *Fruit* pedicels c.5 cm long, c.2.5 mm wide, fruit chestnut-coloured to black, fusiform to cylindical, terete, glabrescent, 11–12.4 cm long, 3.7–4 cm in diameter, length to diameter ratio 2.8–3.4; stipe absent; valve 1.9–2.5 cm wide, margin straight, plane, length to width ratio 4.5–6.8. *Seeds* glabrous, 40–58 mm long (including wing), 9–16 mm wide.

Distribution. Sumatra, Peninsular Malaysia and Singapore (Fig. 23).

Habitat. Primary and secondary forests, and forest by riverside.

Altitude. From 0 to 1000 m.

Uses. Wood used for construction.

IUCN conservation status. Least Concern (Ganesan, 2017m).

Etymology. Latin *sumatranum* = from the island of Sumatra.

Additional Malesian specimens examined. INDONESIA. **Sumatra**: ***Bengkulu***: Taba, 21 vii 1921, *Idris* bb 2272 (L). ***North Sumatra***: Asahan, *s.d., Yates* 2103 (SING); Liman, 29 viii 1933, *Toroes* 5360 (L); Sibolangit, 15 v 1926, *Lörzing* 11705 (SING). ***Riau***: Keritang, 24 vii 1939, *Boschproefstation* bb *28637* (L). ***South Sumatra***: Sungei Rawas, 1880, *Forbes* 3113 (L). ***West Sumatra***: Indrapoera, *s.d.*, *Korthals* 964a (L).

MALAYSIA. **West Malaysia**: ***Johor***: Sungei Biku, 1911, *Down* 16290 (SING); Kota Tinggi, Panti F.R., 11 vii 1961, *Pilus* 104513 (KEP); Jason Bay, Sungei Rhu Reba, 11 vi 1934, *Corner s.n.* (SING); Senai, Senai Rubber Estate, 5 viii 1933, *Teruya* 2438 (SING). ***Melaka***: Batu Tiga, iv 1894, *Goodenough* 1803 (SING). ***Pahang***: Krau Game Reserve, 15 iv 1967, *Whitmore* FRI 3500 (KEP, L, SING); Sg Sat, Ulu Tembeling, 20 vii 1929, *Henderson* 21976 (SING). ***Penang***: Balik Pulau, iii 1892, *Curtis* 2772 (L, SING). ***Perak***: Bidor, 8 vii 1936, *Corner s.n.* (SING); Gunung Boodoo Range, v 1885, *King's collector* 7586 (L); Larut, vi 1886, *King's collector* 7746 (SING); Selama, Titi Ijok, 23 xi 1922, *de Zylua* FMS 5699 (KEP); Slim Hills, Forest Reserve, 9 ix 1966, *Whitmore* FRI 833 (L). ***Selangor***: Ginting Simpah road, 28 iv 1970, *Kochummen* FRI 16012 (KEP, SING); Gombak, Klang Gates, 14 iv 1916, *Watson* CF 531 (SING); S. Buloh Res. Sel., 11 iv 1918, *Hamid* CF 1579 (SING); S. Buloh Res. Sel., 16 ix 1921, *Abu* CF 6503 (SING). ***Terengganu***: Ulu Terengganu, 13 vi 1968, *Cockburn* FRI 10651 (L, SING).

SINGAPORE. Bukit Timah Nature Reserve, 1996, *Lai* LJ 25 (SING); Bukit Timah F.R., Near Singapore Granite Quarry Boundary, 29 vi 1955, *Ngadiman s.n.* (SING); Bukit Timah, 1889, *Ridley s.n.* (SING); Bukit Timah, vi 1894, *Ridley* 6303 (SING); Sungei Buloh, 1894, *Ridley* 6181 (SING).

Occasionally, the older leaves of *Pterospermum sumatranum* have a whitish lower surface as the stellate hairs have rubbed off, leaving a layer of simple whitish woolly hairs.

Pterospermum sumatranum has been confused with *P. blumeanum*, but *P. sumatranum* has leaves that are coriaceous, has fruit that are terete, and is found in Peninsular Malaysia, Singapore and Sumatra, whereas *P. blumeanum* has leaves that are chartaceous, has ribbed fruit, and is found in Sumatra, Java, Bali and Lombok.

Pterospermum sumatranum has also been confused with *P. javanicum*, but *P. sumatranum* has leaves that are coriaceous and glabrescent fruit whereas *P. javanicum* has chartaceous leaves and persistently tomentose fruit.

Regarding nomenclature, herbarium sheet L.0792682 contains flowers, whereas L.0792683 is sterile. The former is therefore selected as the lectotype.

26. Pterospermum zollingerianum S.K.Ganesan, **sp. nov**.

Pterospermum zollingerianum is similar to *P. javanicum* Jungh. but differs by its large fruit, c.14 cm long, which has prominent flanges, and by the indistinct tertiary veins on the leaf lower surface. In *Pterospermum javanicum* the fruit are c.10.5 cm long and are terete, and the tertiary veins are visible on the leaf lower surface. – Type: Sumatra, West Sumatra, Bukit Karang, 2 iii 1984, *Laumonier* YL 6112 (holo L [L.3969583]). **Fig. 24**.

Tree to 40 m tall, 45 cm dbh, buttresses present. *Outer bark* grey, texture not known. *New twigs* covered in tawny hairs, becoming glabrous. *Stipules* caducous, entire, subulate to filiform 3–5.4 mm long, 0.9–1.1 mm wide. *Leaves* alternate, internodes 1.5–1.6 cm long; petiole insertion marginal, petioles 7–9 mm long, 1.5–1.8 mm wide, covered in fawn hairs; blade not lobed, 9.7–13 cm long, 4–5.5 cm wide, length to width ratio 2.8–3.2, symmetrical, elliptic, margin repand, base asymmetrical, oblique, apex acuminate; lamina chartaceous, discolorous, upper surface olive to sepia, glabrous, lower surface fawn, densely covered with fawn-coloured simple woolly hairs interspersed with larger stellate chestnut-

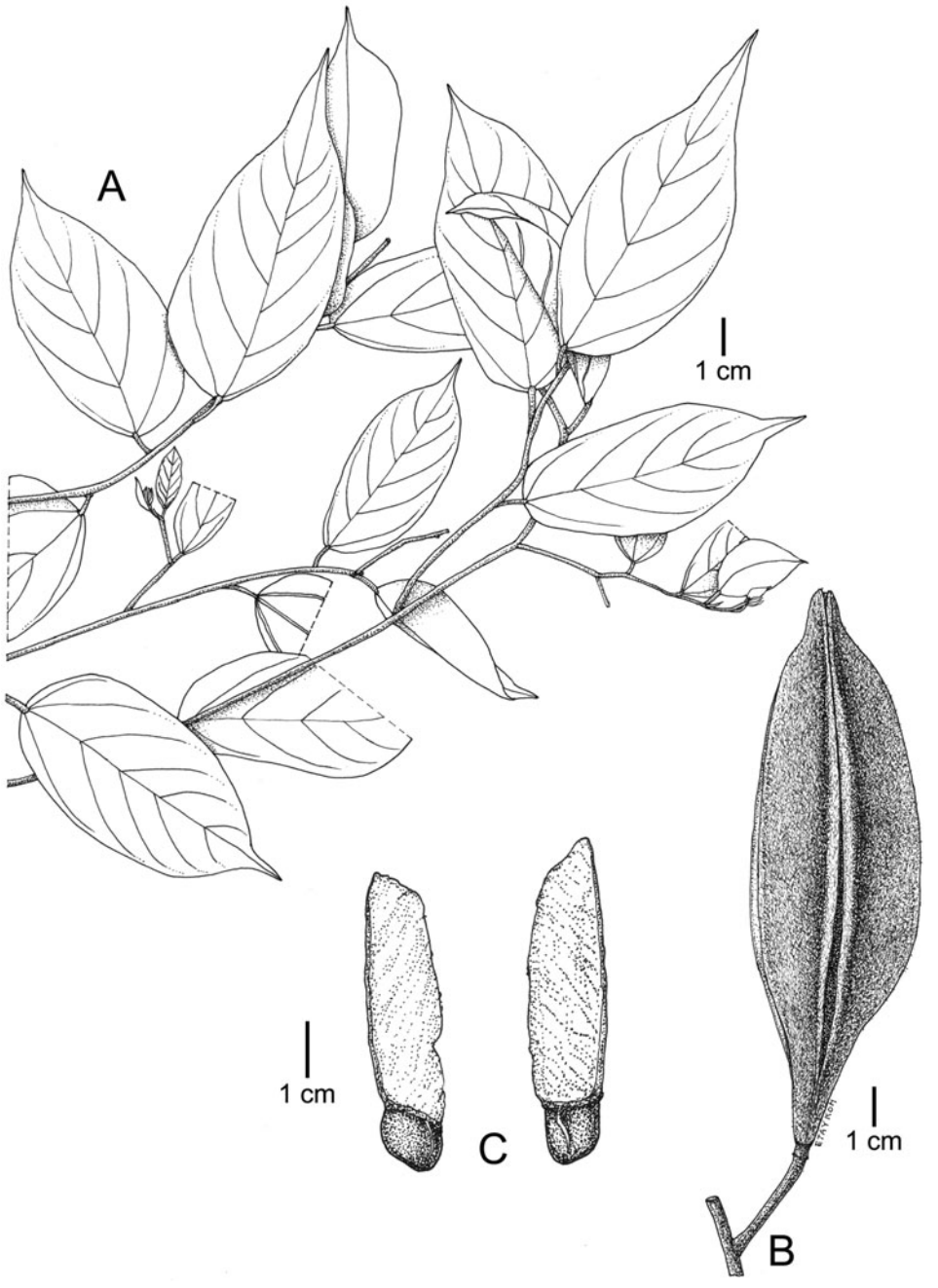

FIG. 24. *Pterospermum zollingerianum* (*Laumonier* YL 6112 [L]). A, Twig; B, fruit; C, seeds. Drawing by Evonne Koh.

coloured hairs; basal veins (excluding midrib) 3 or 4, secondary veins (excluding basal veins) 4 or 5 pairs, tertiary veins not visible on lower surface, quaternary veins obscure on lower surface. *Inflorescence* and *flowers* not known. *Fruit* pedicels c.3 cm, c.4 mm wide, fruit chestnut-coloured, fusiform, angular, persistently tomentose, c.14 cm long, c.4.5 cm wide, length to width ratio c.3.5; stipe absent; valve 2.6–2.7 cm wide, margin straight, raised and forming flange, length to width ratio 5.2–5.4. *Seeds* glabrous, 35–60 mm long (with wing), 5–11 mm wide.

Distribution. Known from three collections made in Sumatra (see Fig. 19).

Habitat. At high elevation between 800 and 1800 m. One of the three known collections is from a limestone area. The other collections lack information on substrate.

Altitude. From 800 to 1000 m.

Uses. None recorded.

IUCN conservation status. Endangered B1ab(iii)+2ab(iii). This higher elevation tree species is endemic to the island of Sumatra in Indonesia, where it is known from West Sumatra province and Aceh Province. The EOO is 4313 km^2 and the AOO is 250 km^2. The known locations of this species are adjacent to protected areas but do not fall within them. The information on herbarium specimens suggest that this species is found at elevations between 800 and 1800 m a.s.l., where loss of habitat by deforestation is likely to be less than at lower elevation. One of the three known collections is on limestone, whereas the other two specimens provided no information on the substrate. Therefore, although the habitat associations of this species are uncertain, it is possible that it is restricted to limestone. There is the threat of mining of limestone in this region, resulting in potential loss of habitat and fulfilling subcriterion b(iii).

Etymology. Latin *zollingerianum* = after Heinrich Zollinger (1818–1859), Swiss botanist and biogeographer.

Additional Malesian specimens examined. INDONESIA. **Sumatra**: ***Aceh***: Gunung Agosan (Kota Lintang), 11 ii 1937, *Boschproefstation* bb 22447 (BO, L). ***West Sumatra***: Bukit Karang, 2 iii 1984, *Laumonier* YL 6112 (L [3], holotype sheet L.0792663); Fort de Kock, 15 iii 1917, *Theunissen* 7 (L).

Doubtful species

Pterospermum subsessile Miq., Fl. Ned. Ind., Eerste Bijv. 3 403 (1861). – Type: Indonesia, Sumatra, Priaman, *s.d.*, *Teysmann* 632 (lecto BO, designated here).

This species was described from leaves only. From the description in the protologue and an examination of the type, it appears to be juvenile material of either *Pterospermum javanicum* or *P. sumatranum*.

Material of insufficient quality to be identified to species

INDONESIA. **Flores**: W. Flores, iv 1965, *Kostermans* 22177 (K). **Java**: *s.d.*, *Koorders* 7822 (K); *s.d.*, *Koorders* 10247 (K). **South Sumatra**: Enggano, vi 1938, *Lutjeharms* 4467 (K), Enggano, vi 1938, *Lutjeharms* 4471 (K).

MALAYSIA. **East Malaysia**: ***Sabah***: Tawau, Quoin Hill Road, *Gibot* SAN 30607 (K); Ranau, Kg Bundu Tahan. *Soibeh* 561 (K). ***Sarawak***: Long Ekan, Baram, *s.d.*, *Munting* et al. S. 52842 (K [2]); Sibu, 1958, *Zehnder* 11712 (K).

PHILIPPINES. **Zambales**: Mansiloc, Buntat, ii 1992, *Reynoso* et al. 4255 (K).

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